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WELLCOME MEDICAL SOCIETY OF LONDON
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CATALOGUE.

GALLERY.

DIVISION I.

ORGANS IN PLANTS AND ANIMALS FOR THE SPECIAL PURPOSES OF THE INDIVIDUAL.

SUBDIVISION I.

ORGANS OF MOTION.

SERIES I. Component Parts of Vegetables and Animals.

" On Physiology.

" BEFORE we give any idea on this subject, we should consider the matter of which an animal consists, otherwise we should confound common matter with animal matter, though they are widely different from each other.

" It is merely from our senses that we come at the knowledge of matter, and also it is by matter alone that we come at the knowledge of our senses; for the senses might exist, and yet a man not be sensible of matter, if no impression was suffered to be made upon his senses.

" Matter, of itself, is an abstract idea; for it is not the matter itself that makes the impression on our senses, but the effects of matter. Thus, when we look at a man, it is not the matter of the man which makes the

impression on our senses, but the different shades of light that are reflected on our retina. Also, when we hear a drum beaten, our sensations are not excited by the drum, but by the vibrations of air produced by the strokes on the instrument.

"The properties of matter also act upon our senses. The sensation of sweet and sour are not the effects of matter, but of the properties of matter upon the tongue. Touch arises from resistance in matter.

"Animal and vegetable matter are only different modifications of common matter. Common matter has no power of action within itself; but animal and vegetable matter, besides possessing the properties of common matter in general, have a power of acting and performing many changes and operations within themselves, and of producing or generating matter of their own kind from themselves. But though they both have a power of performing operations within themselves, and of generating from themselves, in other respects they greatly differ.

"The operations of both animals and vegetables are attended with waste of their component parts. This waste is recruited by a supply of common matter: but common matter cannot be immediately converted* into animal substance: the decay of animal substance cannot be supplied from common matter until it has by certain changes been altered into animal or vegetable matter. Vegetables can immediately convert common matter into their own substance, and be supplied from it, but animals cannot; which proves that animal matter is still further removed from common matter than the vegetable."

John Hunter, MS. Lectures on Surgery, Lect. II.

Sub-series 1. Vegetable Matter.

No.

1. A cutting from a currant-bush, which exhibits at one view the cuticle and bark, the radicles and the stem, the leaf and leaf-stalk, buds, &c.

* "The circumstance of worms, &c. which feed upon earth would seem to afford an exception to this position: it is likely, however, that the earth they take in is only useful so far as it contains animal and vegetable matter. In order to determine this, we should combine an alkaline salt with earth which will destroy any animal or vegetable matter it contains: then wash it thoroughly, and try if a worm will live upon it."

2. Animal Matter.

2. Blood as it coagulates after extravasation.
3. Muscle. [From an ostrich.]
4. Tendon. [From the leg of an ostrich.]
5. Elastic Ligament. [The ligamentum nuchæ of a calf.]
6. Cartilage. [The thyroid cartilage of a turtle (Chelonia Mydas, *Brongn.*)]
7. Bone. [Lumbar vertebræ and os sacrum of a quadruped.]
8. Gland. [The kidney of a lion.]
9. Brain. [Of the Lemur Mongoz.]
10. Nerve.
11. Cellular or connecting membrane. [Portion of the human scrotum.]
12. Investing membrane. [Portion of the human testis, surrounded by the tunica vaginalis.]
13. Cuticle. [From the hand of a child.]
14. Calcareous earth. [The camp olive (Oliva porphyria, *Lam.*)]
15. Oil. [Portion of the skin and fat of a porpesse (Phocæna communis, *Cuv.*)]

Series II. Sap and Blood; their different kinds.

16. Sap of the willow (Salix capræa) coagulated naturally, or inspissated.
17. Sap of the willow coagulated chemically, or precipitated, by means of the super-acetate of lead used in the form of Goulard's extract.
18. Sap of the willow similarly treated.
19. Sap of the willow similarly treated.
20. Sap of the onion (Allium Cepa) coagulated.
21. Sap of the onion, showing the same circumstance.
22. Blood of the lobster (Astacus marinus, *Fab.*) coagulated; as an example of limpid or colourless blood.

"The red part of the blood I choose to consider last, although it has been more the object of attention than the other two, because I believe it to be the least important; for it is not an universal ingredient in the blood of animals, like the coagulating lymph, and the serum, neither is it to be found in every part of those animals who have it in the general mass of their blood.—The blood of the insect tribe is free from any red parts, as is probably that of most animals below them, yet it has been asserted, and supposed, that their blood contains globules, although not red. I have examined the blood of the silk-worm, lobster, &c. and with considerable magnifying powers, but never could discover any thing but an uniform transparent mass." *Hunter, On the Blood,* 4to, p. 40.

23. Blood of a turtle coagulated; as an example of red blood from a cold-blooded animal.

23 A. Human blood coagulated after extravasation. *Prepared in* 1831.

23 B. A portion of a coagulum of human venous blood, which has been immersed in red size injection, and in that state put under the receiver of an air-pump. The section of the coagulum shows the extent to which it has been penetrated by the injection, which is supposed to occupy canals made by the escape of bubbles of carbonic acid gas during the action of the air-pump. The preparation has been dried and preserved in oil of turpentine. See *Philos. Trans.* cviii. pp. 189—190. pl. xi. fig. 1—2. *Donor,* Sir Everard Home, Bart. V.P.R.S. &c. &c.

23 C. A portion of a coagulum of human venous blood, similarly treated. *Donor,* Sir E. Home, Bart.

23 D. A portion of a coagulum of human arterial blood, similarly treated; but preserved in spirit of wine. *Donor,* Sir E. Home, Bart.

24. Serum of human blood, coagulated by heat.

25. Fibrin or coagulated lymph of human blood, from the left auricle and pulmonary veins.

26. Coagulated lymph from the pulmonary artery.

27. Coagulated lymph from the pulmonary artery.

Series III. Parts of Vegetables having evident Motions.

Of Motion in Vegetables.

All plants are not endowed with evident motion, many being perfectly at rest, having no actions going on in them but those of simple growth, which is the most simple state in which we can conceive life to exist.

Some, however, have motions produced in parts of them, from particular causes, as the rising or setting of the sun, &c. Others are affected by the touch, so as to be immediately put into motion. Some have diurnal motions going on regularly and uninterruptedly, but so exceedingly slowly, as to be with difficulty perceived: others, again, have constant motions, at least through the day, going on so quickly as to be easily detected by the eye.

On what circumstances these motions immediately depend,—whether they arise from the action of structures formed for this purpose, or from a series of contiguous structures so conjoined as to produce the effect by their successive motions, we are at present ignorant. It is probable, however, that the power is analogous to the irritability of animals.

28. One of the ternate leaves of Erythrina corallodendron, to show the part between the leaflet and petiole in which the motion of the leaflets takes place after sunset.

"There is an action in plants which appears to be the contrary of expansion; it may be considered as a relaxation, or an action of those parts antagonizing the others which acted through the day, or at other periods, and it takes place at the time these other parts cease to act.

"This action has hitherto been considered as analogous to sleep in animals; whereas, sleep is a total loss of the sensitive principle, and all the actions dependent on volition for the time; and, therefore, can only take place in animals endowed with sensation. It is rather a defect in the animal, than an action, or the exertion of a principle."

John Hunter, MS. Croonian Lectures, No. I.

[The various actions that take place in plants at the close of day, are

described by Linnæus in *Amœnitates Academicæ*, iv. p. 333, under the title *Somnus Plantarum.*]

29. A branch of Mimosa pudica, with two leaves; one of them is in the expanded state; the other contracted, but erect.

[Although one only of the pinnules be touched, the contractile movement is quickly propagated along the other three: it consists of an approximation of the upper surfaces of the opposite subleaflets to each other, with an overlapping of those of the same side.]

30. A portion of a branch of Mimosa pudica, with the leaf bent down, in consequence of the action that takes place at the intumescent part of the joint. The leaf-stalks at the middle and lower part of the preparation appear to have been in the act of recovering their erect position when the branch was removed. The intumescence at the joints, in which the motive power resides, is well seen in this specimen.

"To see if the actions of plants were affected by a continuation of stimulus similar to those of animals, I made the following experiments. As I took for granted that the analogy would go no further than the actions produced by external stimuli, my experiments were only such as had a tendency to these."

——"For the purpose of making my experiments, I took three sensitive plants, having several others for any comparative experiments which might be thought necessary. I first pitched upon one leaf in each plant which was capable of the greatest motion of collapsing and erection; and behind each of these leaves a board was placed, on which was marked the greatest extent of the two motions; so that the leaf was like the index or radius of an arc.

"To have the greatest part of the day before me, I began my experiments at eight in the morning, while the leaves were in full expansion; and I continued them till four in the afternoon; as longer than this would not have been just, for they begin to collapse of themselves between five and six o'clock."

[The leaves were stimulated to act five times during that period; and

the point to which each leaf fell, the time it took to rise, and the point to which it rose, were carefully registered.]

" From these experiments we may draw the following conclusions :—

" That there is no fixed time for any of the leaves of the plants to move through its course.

" That they are less affected as they become accustomed to the stimulus; but the power of collapsing is increased (although not in the same degree), so that they do not move through the same arc.

" That they require a stronger or quicker stimulus to produce motion after being some time accustomed to it; which was evidently seen in comparing these with others which had not been stimulated.

" It may also be observed, that when these plants collapse in the evening, they have nearly the same quantity of flexion as when roughly touched at noon: but if touched after they have collapsed from the effect of the evening, they become much more bent than by the same [degree of] touch at noon. This would seem to arise from a disposition to collapse in the evening, and a power of increasing that disposition and action when stimulated.

" Their collapsing more in the day, and erecting themselves less after a repetition of such actions, may assist in explaining the principle on which this depends." *John Hunter, MS. Croonian Lectures, No. I.*

Subsequent experiments on this subject have been made by Mr. Lindsay (Paper read before the Royal Society, A.D. 1790.), by Dr. Dutrochet (*Journ. de Phys.* xcv. p. 474.), and by Professors Mayo and Burnett (*Outlines of Physiology*, p. 11. 2nd ed. and *Quarterly Journal of Science*, xxv. p. 434.), which prove, "that the tuber at the articulation of each leaf with the stalk is formed by antagonist elastic springs, the superior serving to depress, the inferior to elevate the leaf; for, if the upper part of the intumescence be cut through, the leaf rises more than natural, and no irritation however violent can cause it to collapse; that if the under part be divided, the leaf falls, and by no extent of rest will it again be enabled to rise; also the lateral parts being cut, a lateral flexion is caused towards the wounded side. Similarly acting organs exist at the articulations of the pinnules, and of the leaflets; only in the one case they are

placed laterally, and in the other diametrically opposite to their position on the leaf-stalk: their motions are in accordance with this change of place, and by similar operations may be interrupted." *Journal of Science*, p. 435.

30 A. Two leaves of Dionæa Muscipula, in one of which the terminal lobes are expanded, in the other closed. These appendages are armed with long spines on their edges, and have sharp points on the middle of the upper surface, from which a fluid substance attractive to flies is secreted; but the moment an insect alights on this part, the lobes close, and destroy by pressure and impalement the stimulating cause.

Donor, Sir E. Home, Bart.

31. Leaves of Hedysarum gyrans, in which the small lateral leaflets have a power of moving up and down, with a varying degree of velocity, and without any mutual uniformity or co-operation. These motions take place independent of external stimulus.

32. A branch of Hedysarum gyrans, with tendrils of Passiflora winding round it.

Series IV. Structure of Muscles.

"The most simple mode of investigating an animal body, is, first to consider the matter of which it is composed. In this inquiry we shall find it more than probable that there is but one species of matter which is peculiar to animals, and therefore I shall call it animal matter.

"The blood appears to be the most simple modification of this matter. It is the material out of which all the solids are composed.

"The next modification, or what may be called the simplest organization, is a certain arrangement of this matter, so as to produce some action. This may be of two kinds; first, such an arrangement as may take place in any kind of matter, of which elasticity is one: the second is such as is capable of producing a motion in itself, without the cause being mechanical as in elasticity; this is the composing of a muscular fibre.

"A muscular fibre is one of the simplest constructions of an active

solid; and it is these fibres which compose almost the whole of many animals." *John Hunter, MS. Croonian Lectures, No. IV.*

1. *Muscular Fibre.*

33. A portion of muscle from the neck of a Bull, which has been boiled, and the connecting cellular membrane, vessels, and nerves, removed from the lower part, and the simple muscular fibres there unravelled.

34. The biceps flexor cubiti muscles from the arms of a Negro. That of the right side is in its natural state, the other shortened one half of its length, in consequence of the os humeri of that arm having been fractured obliquely, and having become united with the fractured ends of the bone riding on one another. After the union of the bone, the biceps (together with the other muscles of the arm) became shortened by the interstitial absorption, so as to correspond with the diminished length of the bone, and the arm regained its natural action.

The following history of the case is given by Sir Everard Home, in his *Lectures on Comparative Anatomy*, 4to. 1814. p. 41.

"A Negro about thirty years of age, having had his arm broken above the elbow-joint, the two portions of the os humeri were unfortunately not reduced into their places, but remained in the state in which they were left by the accident, till the bony union had taken place: so that when the man recovered, the injured bone, from the position in which the fractured parts were left, was shortened almost one half of its length. From this circumstance, the biceps flexor cubiti muscle, which bends the fore-arm, was so much longer than the distance between its origin and insertion, that in the most contracted state it could scarcely bring itself into a straight line; this muscle however, in time, as the arm recovered strength, adapted itself to the change of circumstances by becoming shorter, so as to correspond to the diminished length of the bone; and by acquiring a new contraction in this shortened state, it was enabled to bend the fore-arm.

"Some years after this accident the person died, and the circumstance

above mentioned being known, the parts were examined with particular attention: the biceps muscles of both arms were carefully dissected out, and being measured, the one was found to be eleven inches long, the other only five, so that the muscle of the fractured arm had lost six inches, which is more than half its original length: and is distinctly seen in the preparation."

See also *Mr. Hunter's Lectures, delivered by Mr. Home*, 1794-5, MS. p. 156.

35. A portion of the gastrocnemius muscle, injected, dried, and put into oil of turpentine to show its vascularity, on which depends its red colour.

"A muscle, in all animals, is in itself white; and its red colour, found in living animals, and also immediately after death, arises from the blood; for if a red muscle be steeped in water, it will become white; or if the arteries of a part which has red blood be injected with water till it returns by the veins, the muscles soon become white. A red muscle exposed to the air, loses the Modena red, becoming florid."

John Hunter, MS. Croonian Lectures, No. II.

36. Portions of muscle from a Cod-fish (Gadus Morrhua, *Linn.*) which have been steeped in an acid, and reflect iridescent colours in some lights.

2. *Disposition of Muscular Fibre.*

"Muscles are more or less complex, arising generally from the different dispositions of their fibres, which difference is owing to the manner of their arising and being inserted, more particularly the former; and hence we say muscles are straight, broad, radiated, half-penniform, complete-penniform, and complex.

"The most simple muscle would be one whose fibres are in the direction of its body, or in a straight line between the two resisting points, and should be called rectilineal; but there is not in the human body a muscle truly rectilineal; and from what has been observed of the disposition of the muscles and their tendons, and also of their origins, it is hardly possible to have one.

"The straight muscles have fewer fibres, in proportion to their size,

than the oblique; therefore their powers are less: some are round, or nearly so; others are flat and broad; some of these last are radiated.

"The half-penniform muscle, although nearly as simple as any in the body, appears to be the first stage towards combination: it is composed of a series of fibres arising from a bone, tendon, or fascia, but more commonly a tendon, of which the insertion runs nearly parallel to the origin, representing a quill with the feathers of one side taken off. This disposition of fibres, from the mode of origin or general disposition of the bones and fascia above described, is almost as common as any in the body.

"The complete-penniform muscle is two half-penniform muscles joined together.

"The complex muscle is several complete-penniform muscles united into one.

"There are many half-penniform and complex muscles in the human body, but hardly one instance of a distinct complete-penniform muscle.

"In proportion to their combination their fibres are shorter, and a greater number in a given size, which must make them proportionally stronger." *John Hunter, MS. Croonian Lectures, No. IV.*

37. A portion of the diaphragm of a Child, injected, dried, and put into oil of turpentine, to show the radiating disposition of the muscular fibres.

37 A. A portion of the sartorius muscle of the human subject, to show the parallel straight direction of the muscular fibres.

38. A section of a muscle, consisting of a single series of oblique fibres, constituting the half-penniform muscle.

39. A section of a muscle, consisting of a double series of oblique fibres, constituting the complete-penniform muscle.

40. A section of a penniform muscle.

41. A section of a penniform muscle.

42. A section of a muscle, in which the fibres are disposed obliquely in several double series, with tendon intervening; constituting the complex muscle.

43. A longitudinal section of a complex or multi-penniform muscle.

44. A transverse section of a complex muscle, to show the intermixture of the carneous and tendinous fibres.

45. A transverse section of a complex muscle.

46. A section of a hollow muscle:—example a gizzard. A transverse section of the two muscular bellies and their uniting tendons. This specimen is from the Negro Fowl (Gallus Morio, *Temm.*).

3. *Tendon.*

—— "There are also parts called tendons, which are the medium of union between the different parts of the machine and the powers. They have hitherto been considered as belonging to the powers, but I shall rather consider them as a part of the machine itself.

"A tendon is a peculiar substance placed between some muscles or powers, and the parts of the machine to be acted upon by such powers. It is composed of white fibres placed parallel to each other, forming a chord which is extremely flexible, has no sensible elasticity, and is much smaller than the power to which it is attached. Its figure is in general a little rounded; sometimes, however, rather flattened, and in many situations it is broad and thin. In all cases it is extended between the body to be moved and the power. It is sometimes spread out in breadth, and is then called Fascia: this form answers various purposes: its fibres in some situations run pretty parallel, but in general they are interwoven. It has flexibility, strength, and convenience in size. The application of this substance is extremely extensive, complicated, and various."

John Hunter, MS. Croonian Lectures.

47. Portions of tendons from the leg of an Ostrich (Struthio Camelus, *Linn.*), which have in this animal an unusually brilliant lustre.

48. The gizzard of the Negro Fowl, in which the whole of the skin and periosteum are of a violet black colour. The tendons are covered by a similar pigment, which still remains, and indicates the extent of the lateral tendon on one side of this preparation; but has been partially removed from the opposite side, to show the ordinary glistening appearance of the tendon beneath.

49. A tendon from the leg of a Calf, injected, dried, and put into oil of turpentine, to show its small degree of vascularity.

49 A. The tendo Achillis, injected, with part of the gastrocnemius muscle, to show by contrast the difference in the vascularity of these parts.

Donor, Sir William Blizard.

Series V. Application of Muscles.

In the most imperfect [or simplest] animals it is very probable that there is no difference in the structure of parts [of the body]; no fixed parts, so as to divide and determine the motion of the animal to those parts, similar to bones in others; but that the whole is principally muscular, like the urinary bladder, or an intestine. But where animals become more complicated, and have various motions, especially progressive, then the motions become more divided, more partial; for which purpose it is necessary that there should be parts, whose firmness of structure and mode of attachment should divide these motions and determine them to the particular parts.

This structure is different, in different animals: in the caterpillar, the earthworm, the nereis, this structure is the skin: it is divided into rings, all of which have motion on each other, and into each are muscles inserted, so that a variety of motions are produced. If the whole act, the animal is shortened; if the whole from end to end act only on one side, the animal is bent; but if a succession of motions from one end to the other takes place, then progressive motion is produced.

In the insect, when arrived at its perfect state; in the lobster, spider, &c., whose parts are still more complicated, and answering a greater variety of purposes, we find this substance still firmer, and of different texture: thus in the flying insect and spider, it is horn; in the lobster, &c. it is bone. In them, too, it makes the covering of the animal; but besides these, there are processes going inwards for the attachment of muscles.

In amphibia, lizards, snakes, &c., there is another, or internal apparatus for motion, besides the external; so that they have both the external [skeleton] which we have described, and another internal [one].

In the more perfect animals these external parts are almost entirely wanting, and make hardly an external part of the animal for motion, so that the muscles and their attachments change sides: this is peculiar to fishes, birds, and quadrupeds.

50. A transverse section of the valves of an Oyster (Ostrea edulis, *Linn.*), showing the adductor muscle, and the disposition of its fibres at right angles to the shell.

51. The lower flattened valve of an Oyster, showing by a transverse section the extent and shape of the adductor muscle.

52. The valves of a Cockle (Cardium edule, *Linn.*), divaricated to show the application of the fibres of the two adductor muscles.

53. A fresh-water Muscle (Anodon cygneus, *Sowerby*), of which part of the mantle-valve is removed, and the mantle dissected away, to show a pair of muscles going obliquely from the body of the animal to their points of insertion in the valves. A bristle is placed between them.

54. The calcareous tube of an Acorn-shell (Balanus sulcatus, *Lam.*), laid open to show the attachments of the muscles to the moveable opercular valves.

55. Part of the margin of a large Medusa (Rhizostoma cerulea, *Cuv.*), on the inferior edge of which, the membrane is disposed in numerous minute plicæ, running in the direction of the circumference, and giving to it a fibrous or muscular appearance.

56. A Holothuria (Holothuria tubulosa), laid open to show fasciculi of muscular fibres disposed in pairs and traversing the body longitudinally; being attached along the whole of their exterior surface to the thick coriaceous integument. In the intervals there are transverse fibres.

57. A Leech (Hirudo medicinalis, *Linn.*), having part of its external tegument dissected off to show its longitudinal subcutaneous muscles.

58. Portion of a Nereis (Lycoris foliosa, *Catal. Nat. Hist. No.* 254.), showing two

series of muscles, which extend along the dorsal aspect from one end of the animal to the other: these are intersected at regular distances, corresponding to the breadth of the segments, so as to determine the action of the animal to such parts.

59. A section of the larva of a large North American Moth (Bombyx regalis, *Fabr.*), showing two lateral series of muscles, which extend along the dorsal and ventral aspects, through the whole length of the body. These are intersected at determinate distances, corresponding to the several segments to which they are to give motion.

60. A section of the claw of a Lobster, showing the fibres of the penniform muscle arising from the manus and inserted into the tendon of the pollex or moveable claw.

61. A section of the pollex and manus of the claw of a Lobster, showing the attachment of the penniform adductor in another point of view.

62. The stem of the Eared Barnacle (Otion Cuvieri, *Leach.*), deprived of its external theca to show two series of oblique muscular fibres which arise from a central line or tendon on one side of the stem, and, winding spirally round, are inserted into a similar line on the opposite side of the stem. Beneath these oblique fibres, whose office is to compress the peduncle, others may be observed which are longitudinal, for the purpose of shortening the peduncle.

63. A transverse section of one of the arms of a large Cuttle-fish (Onychoteuthis, *Lichtenstein, Isis von Oken,* A.D. 1818, tab. xix. See also Loligo Banksii, No. 166 D. *Catal. Nat. Hist.* p. 33.), showing the complex arrangement of the muscular fibres.

64. A portion of the upper part of the œsophagus of a Lion, showing the disposition of the muscular fibres; those of the outer layer running obliquely, but in different directions, like the fibres of a penniform muscle; the fibres of the inner layer also running obliquely, but in directions the reverse of the outer fibres.

Series VI. Application of Elastic Powers.

1. *As an Antagonist to Muscle.*

"Where constant action is not necessary, muscles alone are employed, as in the greater number of moving parts in most animals; and where any position is required to be constant, and the motion only occasional from being seldom wanted, there elasticity is alone employed for the purpose of constant position, and muscles for the occasional action.

"Some bivalves (as the oyster,) have a strong muscle passing between the shells, for closing them occasionally; but for opening them, no muscles are made use of, as this is performed by an elastic ligament in the joint of the two shells, which is squeezed, when shut, by the contraction of the muscle; and when the muscle ceases to contract, the elasticity of the ligament expands it, so that the shell is opened."

Hunter, On the Blood, 4to. 1794. p. 111.

65. A longitudinal section of the valves of an Oyster, to show the adductor muscle, and its antagonist the elastic ligament at the hinge, above described.

66. A transverse section of the connecting ligament of the valves of a fresh-water Muscle, showing that its structure is fibrous, the fibres being perpendicular to the plane of the shell, and converging towards the centre; so that when the shell is closed, these fibres are in a state of compression, and consequently have a constant tendency to antagonize the adductor muscle, open the shell, and retain it in that state, independent of any muscular action.

67. A longitudinal section of the same ligament, made by dividing the valves from one another.

68. A section of the stem of the Eared Barnacle, showing the semitransparent elastic external theca, which has a constant tendency to rectify the position of the peduncle, when it is inflected by any action of the muscular fibres which it incloses.

69. An Eared Barnacle, with the elastic theca removed from one side, and the longitudinal and oblique muscles turned down from the stem. The tentacula and the muscles which move them are also exposed.

2. *In aid of Muscular Action.*

Animals which have long necks, more especially those whose necks stand in some degree horizontal, or at least project beyond the body, have elastic ligaments placed on the upper side to support the head and neck; so that the muscles have less power to exert in the motion of the head and neck, these ligaments keeping them in a kind of equilibrium. In birds these ligaments are placed between what may be called the roots of the spinal processes, viz. as far towards the posterior surface of the vertebra as possible, so as to be behind the centre of motion of each vertebra: but in quadrupeds, whose necks are much deeper or broader, and whose spinal processes of the back rise high, so as to give origin to muscles, &c., these ligaments rise principally from the tips of these processes along the back, and extending forwards towards the neck, pass along its upper edge. In this course they send broad processes into the posterior surfaces of the vertebræ, and are at last fixed in the posterior process of the os occipitis.

This long sweep which the ligament takes in the bend of the neck, is owing to the short ones bending (it) in that direction. The camel is perhaps one of the best instances of this, probably the camelopard, from its having a long neck. The long sweep of ligament is double, but the processes sent down from them are single.

Hunterian MS. Catalogue. See also *Hunter, On the Blood,* 4to. p. 111.

70. Three vertebræ from the neck of an Ostrich (Struthio Camelus), showing the elastic ligaments which pass between the spinous processes, close to the vertebræ.

71. A single cervical vertebra of an Ostrich, showing the attachment of one of these ligaments to the root of the spinous process.

72. Three dorsal vertebræ of an Ostrich, longitudinally bisected, to show a similar

disposition of elastic ligament between the spinous processes of this part of the vertebral column.

73. A portion of ligamentum nuchæ from a Bull.

73 A. A portion of the ligamentum nuchæ of the Alpaca (Camelus Pacos, *Linn.*), in which animal it consists of two parallel rounded chords, and the processes sent off to the spines of the cervical vertebræ remain distinct from each other to their insertion. *Donor*, Mr. Owen.

74. A portion of the elastic ligamentous substance from the belly of an Elephant.

"On the abdomen of most quadrupeds are to be found elastic ligaments, especially on that of the elephant, which is a constant support to the parts in their horizontal position; and even the cellular membrane of the elephant has a degree of elasticity much above what is generally met with in cellular membranes. Hence there is less expense of muscular contraction in such parts." *Hunter, On the Blood*, 4to. p. 111.

75. A longitudinal section of a portion of the aorta of a Horse, in which elasticity and muscular contraction are combined.

Series VII. The different Substances of which the Skeleton is composed.

76. Gelatinous membrane. [The exterior transparent covering of a Salpa laid open; which is the only firm part of the animal for sustaining and protecting its very delicate organs.]

77. Horn. [The feather-shaped substance from the back of the Calamary (Loligo vulgaris, *Lam.*)]

78. Cartilage and gelatinous substance. [A portion of the spine of a Sturgeon (Acipenser Sturio, *Linn.*)]

79. Cartilage combined with calcareous earth. [Phosphate of lime, but only in a very small proportion. The specimen is a portion of the jaw of a Shark.]

80. Membrane and calcareous earth. [Phosphate of lime in a larger proportion,

as bone. The specimen is the femur of a Negro Fowl, deprived of its dark-coloured periosteum, and bleached white.]

81. Membrane and calcareous earth. [Carbonate of lime. The substance called Cuttle-bone, from the back of the Cuttle-fish (Sepia officinalis, *Linn.*)]

82. Calcareous earth. [The shell of a Cowry (Cypræa Tigris, *Linn.*), consisting almost entirely of carbonate of lime.]

Series VIII. Structure and Growth of Shell.

Shell is a substance made use of chiefly as a defence from external accidents; serving the purpose of a retreat, as in univalves, bivalves, and so on; but in some Insecta, it not only answers this purpose of external covering, but serves as levers on which the muscles may act so as to bring about progressive motion, and makes an instrument analogous in some measure to a hand, or to teeth; as, for example, in the claw of the lobster, where it is constructed so as to lay hold of and pinch whatever molests it. *Hunterian MS. Catalogue.*

1. *In Zoophytes.*

82 A. A Madrepore (Meandrina areolata, *Lam.*), the lower part of which has been steeped in dilute muriatic acid, and partially dissolved. The traces of animal matter are hardly to be perceived. *Prepared in* 1831.

82 B. A Madrepore (Caryophyllia Cyathus, *Lam.*), the upper part of which has been similarly treated. *Prepared in* 1831.

82 C. A portion of Caryophyllia sinuosa, *Lam.*, which has been similarly treated, and exhibits the animal constituent sufficiently organized to preserve the membranaceous form, and in some degree the foliated character of the Madrepore. *Prepared in* 1831.

82 D. A Madrepore (Oculina hirtella, *Lam.*), similarly treated, and exhibiting a greater proportion of animal matter; probably, however, from having been incrusted with some sponge. *Prepared in* 1831.

82 E. A Coralline (Dichotomaria, *Lam.*), the terminal joints of which have been subjected to the action of dilute muriatic acid, and reduced to their

membranaceous constituent, which retains perfectly the configuration of the entire joints. *Prepared in* 1831.

83. A small mass of red Organ-pipe Coralline (Tubipora musica, *Linn.*), showing the natural colour and disposition of the tubes.

84. A portion of Tubipora musica, which has been steeped in an acid, and thereby deprived of its colour and earthy material. Many of the small polypes may be seen situated at the open mouths of the tubes; and the membrane reflected from them, down the interior of the tubes, may also be traced in a few places.

85. A few of the tubes of the same Zoophyte similarly treated, showing the transverse septa that connect the tubes at intervals of about ten lines.

"The universal and only hardening principle of these madrepores and millepores was proved to be carbonate of lime, with the single exception of *Millepora polymorpha*, which also appears to be differently constructed from other *Milleporæ*. With this single exception, carbonate of lime seems to be the only hardening substance in these bodies; and when every circumstance is considered, an exact similarity is to be found between the substance forming the various shells, and that which forms the *Madreporæ* and *Milleporæ;* and the nature of these bodies is so completely the same, that the changes or gradations of the one are to be found in the other. For the chemical characters which distinguish the porcellaneous shells are in a great measure approached by those of *Madrepora virginea;* and those which were noticed in the *Patellæ* correspond precisely with the Madrepores and Millepores which afford a gelatinous substance; and lastly, the characters of the membranaceous part, exhibited by the shells formed of nacre or mother-of-pearl, are in like manner to be found among some of the Madrepores and Millepores, such as *Madrepora ramea*, *Millepora fascialis*, *Millepora truncata;* for these, like the *Turbo olearius* and *Haliotis Iris*, are composed of a fibrous membrane, hardened by carbonate of lime.

"It appears, therefore, that the Madrepores and Millepores, like the various shells, are formed of a gelatinous or membranaceous substance,

hardened by carbonate of lime; and the only difference is the mode according to which these materials have been employed.

" The experiments on *Tubipora musica* proved, that in composition it resembled the foregoing substances."

Mr. Hatchett, Experiments on Zoophytes, &c. Philos. Trans. xc. 1800. p. 361.

85 A. A thick stem of jointed coral (Melitæa ochracea, *Lam.*), the lower part of which has been subjected to the action of dilute muriatic acid, to show the reticular disposition of the flattened gristly substance that is interposed between the portions of earthy coralline material.

Prepared in 1831.

85 B. Smaller branches of Melitæa ochracea; one of which has been similarly treated with dilute muriatic acid, so as to show the form of the interarticular substances. *Prepared in* 1831.

85 C. Another portion of Melitæa ochracea, the terminal branches of which have been similarly treated, and exhibit the external membranaceous covering that surrounds the coralline part, and extends from joint to joint. There is scarcely a trace of this membrane to be observed on the larger branches.

Prepared in 1831.

85 D. A branch of Melitæa coccinea, *Lam.*, the terminal divisions of which have been steeped in dilute muriatic acid, to show the gristly nature of the joints, which resist the action of the acid in this, as in the preceding species. *Prepared in* 1831.

85 E. A portion of jointed Coral (Isis Hippuris, *Linn.*), which has been partially steeped in dilute muriatic acid, and there become semi-transparent from the removal of the earthy material. The joints in this coral are of a horny nature, and smaller than the intervening calcareous parts.

85 F. Another portion of Isis Hippuris, the lower part of which has been longer subjected to the action of the acid, and almost reduced to its membranaceous constituent. The terminal branches are covered by the cortical animal part. *Prepared in* 1831.

" Two species of Isis were next examined, namely, Isis ochracea and Isis Hippuris: both of these were proved to be formed of regularly organised membranaceous, cartilaginous, and horny substances, hardened in

the last-mentioned species merely by carbonate of lime; but in the Isis ochracea, with the addition of a very small portion of phosphate of lime." *Hatchett, On Zoophytes, ut supra,* p. 362.

85 G. A portion of the axis of Antipathes politum, reduced to its membranaceous constituent by long maceration in acid. A transverse section is suspended, which exhibits the concentric disposition of the membranes.

Prepared in 1831.

"Another species of *Gorgonia* was next examined, the stem of which is from one quarter to nearly half of an inch in diameter in the thickest parts; of a black colour, and a high polish, like black sealing-wax; it has probably been considered as a variety of *Gorgonia Antipathes.*

"This, by immersion during twenty-eight days in dilute nitric acid, gradually became semi-transparent, and of a bright brownish yellow. In this softened state, it was steeped two days in water, and was then opened longitudinally. By this, the whole structure became apparent, and consisted of thin coats or tubes of a beautiful transparent membrane, which, beginning from a central point, progressively became larger, according to the order by which they receded from the centre.

"These membranes were so delicate, that the fibrous texture could scarcely be discerned.

"The acid in which this species had been steeped was tinged with very pale yellow. Ammoniac being added, changed it to a deep yellow or orange colour; but the transparency of the liquor was not disturbed by this or any of the other precipitants which had been employed in the former experiments.

"When this *Gorgonia* was exposed to a red heat, it crackled and emitted a thick smoke, with the smell of burned horn. The shape was soon destroyed, and a compact coal remained. By continuing the red heat, a very small portion of white matter was obtained, which, as far as the quantity would allow, was proved to be muriate of soda, with some carbonate of the same." *Hatchett, On Zoophytes, ut supra,* p. 349.

86. A specimen of Gorgonia.

87. A portion of Gorgonia verrucosa, *Lam.*, the axis of which is only partially covered with the cortical part.

"The results of the experiments on certain *Gorgoniæ* such as *ceratophyta*, *Flabellum*, *suberosa*, *pectinata*, and *setosa*, were not a little remarkable; for when the two parts which compose these *Gorgoniæ* (namely the horny stem and the cortical substance by which it is coated) were separately examined, it was proved,

"1st. That the stems of these *Gorgoniæ* consist of a substance analogous to horn; and that by long maceration in dilute nitric acid, this horny substance becomes soft and transparent, so as to resemble a cartilaginous or tendinous body; moreover, the stems of these *Gorgoniæ* afford a quantity of phosphate of lime, but scarcely any trace of carbonate.

"2. That the cortical part, on the contrary, consists principally of carbonate of lime, with very little or none of the phosphate; and the carbonate of lime is deposited in and upon a soft, flexible, membranaceous substance, which seems much to approach the nature of cuticle."

Hatchett, On Zoophytes, ut supra, p. 363.

88. The red Sea-pen (Pennatula phosphorea, *Linn.*), laid open to expose the slender cylindrical internal axis, or bony stem.

89. The kidney-shaped Sea-pen (Renilla violacea, *Quoy & Gaimard,*), one half of which has been subjected to the action of dilute muriatic acid, which has removed the colour; but from the small proportion of calcareous matter in this species, has not visibly diminished the bulk or altered the form of that part.

90. A longitudinal section of the finger-shaped Sea-pen (Veretillum cynomorion, *Lam.*). In this species the central axis is almost wholly reduced to a ligamentous structure. Bristles are placed in apparently natural canals, that extend in the direction of the longitudinal axis of the body, and terminate in more expanded cavities within the lesser obtuse extremity.

91. A portion of Lobularia digitata, *Lam.*, of which a section has been made near the base. In this species the firm parts are mere calcareous spicula dispersed throughout the general mass.

92. A similar specimen.

93. A section of a Sponge (Spongia officinalis, *Linn.*), to show its reticular structure. In the sponges, as in the preceding, the hard parts consist of siliceous or calcareous spicula.

——"The various sponges which were afterwards subjected to experiment were proved to be completely formed by the same membranaceous or horny substance, which became varied by the modifications of a more delicate construction, rather than by any essential difference in composition." *Hatchett, on Zoophytes, ut supra*, p. 364.

2. *In Testaceous Animals.*

"In the porcellaneous shells, such as *Cypreæ*, &c., this substance [the animal matter] was proved to be much less in quantity than those which were afterwards mentioned; and although of a quality which (like a cement or gluten) served to bind and connect the particles of carbonate of lime firmly together, so small was the degree of natural inspissation, and so little advanced was the degree of organization, that when the carbonate of lime was dissolved, even by very feeble acids, little or no vestige of jelly, membrane, or cartilage could be perceived; nor indeed could any be detected, but by the small portion of animal coal which was formed when these shells had been exposed for a short time to a low red heat.

"But, proceeding from shells of this description to others tending to the nature of nacre or mother-of-pearl (such as some of the *Patellæ*), a substance was left *untouched by the acids*, which had the appearance of a yellowish transparent jelly*: so that the substance which served merely as a gluten in the porcellaneous shells, was not only more abundant in these *Patellæ*, but being more inspissated was become immediately visible and palpable.

"In the common oyster these qualities were more strongly marked; and in the river muscle, and in the shells composed of the true nacre or mother-of-pearl, this substance was found not only to constitute a large

* "The term jelly is here employed only to denote the degree of consistency of this substance, which in its nature is very different from the varieties of animal jelly called Gelatin."

part of the shell, but even to be more dense, so as no longer to appear gelatinous; and in addition to these, strong and visible marks of organization were stamped on every part, and a perfect membranaceous body remained, composed of fibres arranged parallel to each other, according to the configuration of the shells."

Hatchett, On Zoophytes, ut supra, p. 358.

93 A. A porcellaneous shell (Cypræa Tigris), with the soft parts. One of the lobes of the mantle, the secreting organ of the shell, is protruded.

Prepared in 1831.

94. One of the valves of the common Muscle (Mytilus edulis, *Linn.*), which has been steeped in an acid to dissolve and separate the earthy part (carbonate of lime), and show the animal part retaining the membranaceous form.

94 A. One of the valves of the fresh-water Muscle (Anodon cygneus), which has been similarly treated, and exhibits similar results.

Donor, Charles Hatchett, Esq. 1802.

The following is the process employed by that gentleman in investigating the nature of shell, and of which this and subsequent donations from him are the results:—

"When shells were examined, they were immersed in acetous acid, or nitric acid diluted, according to circumstances, with four, five, six, or more parts of distilled water; and the solution was always made without heat.

"The carbonate of lime was precipitated by carbonate of ammonia or of potash; and phosphate of lime (if present) was previously precipitated by pure or caustic ammoniac.

"If any other phosphate, like that of soda, was suspected, it was discovered by solution of acetite of lead.

"Bones and teeth were also subjected to the action of the acetous or diluted nitric and muriatic acids.

"The dissolved portion was examined by the above-mentioned precipitants; and in experiments where the quantity of the substance would permit, the phosphoric acid was also separated by nitric or sulphuric

acid. The phosphoric acid thus obtained, was proved, after concentration, by experiments which, being usually employed for such purposes, are too well known to require description.

"It is necessary moreover to observe, that as the substances examined were very numerous, and my principal object was to discover the most prominent characters in them, I did not, for the present, attempt in general to ascertain minutely the proportions, so much as the number and quality of their respective ingredients.

"The greater part, if not all, of marine shells, appear to be of two descriptions, in respect to the substance of which they are composed. Those which will be first noticed have a porcellaneous aspect, with an enamelled surface, and when broken are often in a slight degree of a fibrous texture.

"The shells of the other division have generally, if not always, a strong epidermis, under which is the shell, principally or entirely composed of the substance called *nacre* or mother-of-pearl.

"Of the porcellaneous shells, various species of Voluta, Cypræa, and others of a similar nature, were examined.

"Of the shells composed of *nacre*, or mother-of-pearl, I selected the Oyster, the river Muscle, the *Haliotis Iris*, and the *Turbo olearius*."

Hatchett, Experiments on Shell and Bone, Philos. Trans. lxxxix. 1799, p. 315.

95. The shell of an Oyster (Ostrea edulis) similarly treated, showing the succession of laminæ of animal membrane, in and upon which the earthy matter is deposited. The flattened valve is suspended:—the concave valve contains the animal.

96. The shell of a common Snail (Helix hortensis) similarly treated. Nothing but the animal part remains, which still retains in some measure the form of the shell.

97. A specimen of an English fresh-water shell (Lymnæa auricularia, *Lam.*). It has been subjected very little, if at all, to the action of acid, but seems rather intended to show how the shell protects the soft parts of the animal.

97A. Two species of fresh-water shell [of the genus Neritina, *Lam.*:—the lower suspended specimen is Neritina fasciata, *Lam.*]. They have been treated with an acid, as in the preceding examples, but in different degrees. In the specimen which lies at the bottom of the glass, very little of the earthy part of the shell remains.

Donor, Charles Hatchett, Esq.

98. Portions of an Ear-shell (Haliotis), which have been similarly treated.

98 A. Portions of an Ear-shell (Haliotis Iris), which have been more completely deprived of the earthy material. *Donor*, Charles Hatchett, Esq.

98 B. The shell of Haliotis tuberculata, *Linn.*, part of which only has been steeped in an acid, to show that the animal matter retains the characteristic marks of the shell, after the earthy part has been removed. Below this is suspended a portion of mother-of-pearl, probably part of a valve of Meleagrina margaritifera, *Lam.*, which has been treated in the same way. *Donor*, Charles Hatchett, Esq.

98 C. The membranaceous part of a piece of mother-of-pearl.

Donor, Charles Hatchett, Esq.

98 D. Numerous small pearls, which have been immersed in acetous acid, and thus reduced to their membranaceous constituent.

[It was in this state that they were swallowed by the luxurious ancients; the earthy part only being dissolved.]

Donor, Charles Hatchett, Esq.

"The same experiments were made on pearls, which proved to be similar in composition to the mother-of-pearl; and, so far as their size would enable me to discern, they appeared to be formed by concentric coats of membrane and carbonate of lime: by this structure they much resemble the globular calcareous concretions, found at Carlsbad and other places, called Pisolithes.

"The wavy appearance and iridescency of mother-of-pearl, and of pearl, are evidently the effect of their lamellated structure and semi-transparency; in which, in some degree, they are resembled by the lamellated stone called Adularia."

Hatchett, On Shell and Bone, ut supra, p. 320.

99. The shell of a Wreath (Turbo pica), with the operculum, which has been partially submitted to the action of an acid.

100. Portions of the shell of a Turbo, which have been submitted for a longer time to the action of an acid, so as to leave little else but the animal matter.

100 A. A turbinated shell, which has been similarly treated, showing the strong outer epidermis, and the bright nacre, or mother-of-pearl substance, of which the shell is chiefly composed.

100 B. Portions of the animal substance of a turbinated shell.

101. The soft parts of a Turbo, with the operculum attached. Also the detached operculum of another specimen, in the same bottle.

In this species the operculum is calcareous, of a spiral structure, convex externally, flattened, and with a corneous surface where it adheres to the foot of the animal.

102. The soft parts, and shell, of Purpura patula, *Lam.* The operculum has been detached from the foot of the animal: from its small size and horny nature it can be retracted some way within the shell.

103. Portion of a Teredo navalis, showing the opercular valves which close the external entrance of the shelly tube. Bristles are placed in the syphons.

103 A. Portions of the tube of Teredo gigantea, which have been submitted to the action of an acid, as in the preceding specimens, showing the proportion of animal matter in this shell. *Donor*, W. T. Brande, Esq.

103 B. Portions of the tube of a marine animal, similarly treated.

Donor, W. T. Brande, Esq.

3. *In the Cuttle-fish.*

"Some experiments which I have lately made upon the Cuttle-bone of the shops, have proved that the term *bone* is here misapplied, if the presence of phosphate of lime is to be regarded as the characteristic of bone; for this substance, in composition, is exactly similar to shell, and

consists of various membranes, hardened by carbonate of lime, without the smallest mixture of phosphate."

Hatchett, On Shell and Bone, ut supra, p. 321.

Similar experiments, with respect to the proportion of animal and earthy material in this substance, were made by Mr. Hunter (many years antecedent), of which the following specimens are the results. The menstruum employed was dilute muriatic acid.

104. An oblique section of the dorsal plate of a Cuttle-fish (Sepia officinalis), to show its laminated structure.

105. A longitudinal section of the dorsal plate of a Cuttle-fish, showing the laminated structure in another point of view.

106. A corresponding section of another specimen of the dorsal plate of a Cuttle-fish, which has been steeped in dilute muriatic acid and deprived of its earthy part, to show that the proportion of animal matter that remains is sufficiently well organized and abundant to preserve the form and structure which is exhibited in the preceding preparation.

107. The outer lamina of the dorsal plate of a Cuttle-fish, entirely deprived of its earth and dried. In the preceding section, which is the counterpart of this preparation, it is seen *in situ*.

108. The membranaceous constituent of the dorsal plate of a Cuttle-fish.

109. A large portion of the membranaceous constituent of the same substance, which shows very distinctly its laminated structure.

4. *In Crustaceous Animals.*

"There is reason to conclude (therefore), that phosphate of lime, mingled with the carbonate, is a chemical characteristic which distinguishes the crustaceous from the testaceous substances; and that the principal difference in the qualities of each, when complete, is caused by the proportion of the hardening substances, relative to the gluten by which they are cemented; or by the abundance and consistency of the gelatinous, membranaceous, or cartilaginous substance, in and on which the carbonate of lime, or the mixture of carbonate and phosphate of lime, has been secreted and deposited. Moreover, as the presence of phosphate of lime,

mingled with carbonate, appears to be a chemical character of crustaceous marine animals, there is every reason to conclude that Linnæus did right not to place the Echini among the testaceous ones."

Hatchett, On Shell and Bone, ut supra, p. 324.

110. The outer crust of an Echinus (Siderites Hystrix, *Lam.*), from which the earthy constituent has been partially removed by the action of an acid.

111. A section of the crustaceous covering of the claw of a Lobster, which has been similarly treated, and has become soft and elastic, of a yellowish white colour, but still retaining its original figure.

Series IX. Structure and Growth of Bone.

Bone is a compound of animal substance and calcareous earth, and serves to support the other parts of the machine, so as to allow of the different parts being kept at a certain distance from each other, and to be acted upon by the muscles or moving powers of the body.

These (the Bones) are of different shapes in almost every class of animals, varying as it is necessary for defence from external accidents, strength, velocity, or convenient attachment of muscles.

In some they are similar to shell, serving as a house for the animal, as in the turtle; and in the more perfect animals they serve the same purpose for particular parts.

They are of different consistence in fishes and quadrupeds; in the first, being chiefly animal substance; in the latter, containing a considerable quantity of earth.

In quadrupeds, in some they are very cellular, thin, and spongy; in others, very hard, solid, and compact, according as strength is required.

Hunterian M.S. Catalogue.

1. *Component Parts of Bone.*

a. *In Fishes.*

112. The vomer of a Cod-fish (Gadus morrhua), which has been steeped in an acid, in order to remove the calcareous earth, and show the proportion of animal substance, which in this species is very considerable.

113. Part of the lower jaw (Os dentale, *Cuv.*) of a Cod-fish, which has been prepared in the same manner, to show the same circumstances.

114. Part of the osseous apparatus of the pectoral fin (Os humerale, *Cuv.* Os claviculare, *Geoffroy, Meckel.*) of a Cod-fish, prepared in the same manner.

115. The cubitus, radius, and carpal bones of a Cod-fish, similarly treated.

"The bones of fish, such as those of mackarel, brill, and skate, afforded phosphate of lime; and the only difference was, that the bones of these fish appeared in general to contain more of the cartilaginous substance, relative to the phosphate of lime, than is commonly found in the bones of quadrupeds, &c.

"The different bones also of the same fish were various in this respect; and the bones about the head of the skate only differed from cartilage, by containing a moderate proportion of phosphate of lime."

Hatchett, On Shell and Bone, ut supra, p. 326.

b. *In Mammalia.*

116. A section of the tympanum of a whale-bone Whale (Balæna Mysticetus, *Linn.*), similarly treated.

117. A section of the solid part of a human femur, which has been steeped in an acid, dried, and preserved in oil of turpentine, to show the animal part.

"It is scarcely necessary for me to mention the usual effects of acids on bones steeped in them, as they are known to every physiologist and anatomist.

"In every operation of this nature, the ossifying substance, which is principally phosphate of lime, is dissolved, and a cartilage or membrane of the figure of the original bone remains.

——"It is also known that the nature of bone is more influenced by the greater or less predominance of the membranaceous or cartilaginous part, than by any other cause. It is not, therefore, for me to add any thing to this part; and in respect to the substance which is the cause of ossification, little also requires to be mentioned, for this (as has been already observed) is known principally to consist of phosphate of lime."

Hatchett, On Shell and Bone, ut supra, p. 325.

c. *In Fossil Bones.*

The following preparations are specimens of bones in a fossil state, which have had the earthy part removed by means of dilute muriatic acid; showing that, under favourable circumstances, bones will retain their animal matter for an immense length of time.

118. A glossopetra, or shark's tooth in a fossil state, which has been steeped in an acid. The external lamina, or what appears to be analogous to enamel, has separated from the central portion of the tooth, and has sufficient animal matter remaining to preserve its form. The central portion, or body of the tooth, still remains in a completely fossil state.

119. The external lamina of a glossopetra, separated by means of an acid; showing nearly the same circumstances as the preceding specimen, of which it appears to have formed a part.

"In the shark's tooth, or glossopetra, the enamel is composed of animal substance and calcareous earth, and is nearly in the same quantity as in the recent; but the central part of the tooth has its animal substance in the state of mucus interspersed in the calcareous matter.

Observations on some Fossil Bones, by the late John Hunter, Esq. F.R.S., Philos. Trans. lxxxiv. 1794, p. 415.

120. A small portion of fossil bone deprived of its earth.

121. A larger portion of fossil bone, prepared in a similar manner.

122. A portion of fossil bone from an animal belonging to the genus Bos, prepared in a similar way.

123. The animal part of a portion of a Deer's horn (Cervus giganteus, *Goldfuss.*), from Ireland, in a fossil state.

124. The animal part of some small portions of the cranium of the Ursus spelæus or Bear of the Caverns, from Bayreuth in Germany.—The paper by Mr. Hunter above quoted is on the subject of the fossil bones found in these caverns.

125. A molar tooth of one of the same fossil bears, which has been treated with acid in the same manner as the preceding preparation, and shows that it has retained a very large proportion of its animal matter.

126. The animal part of a section of a tusk of the same species of Bear, dried and varnished.

127. A portion of a tusk of the same animal, in spirit, showing the very large proportion of animal matter which remains after the phosphate of lime has been removed by means of acid.

"In incrusted bones, the quantity of animal substance is very different in different bones. Those from Germany, especially the harder bones and teeth, seem to contain all the animal substance natural to them; they differ, however, among themselves in this respect."

John Hunter, On Fossil Bones, ut supra, p. 416.

128. A small section from the anterior part of a molar tooth of the Mammoth (Mastodon giganteum, *Cuv.*), from the banks of the River Ohio in North America; which has been treated with acid, dried, and varnished, to show the proportion of animal matter.

129. A larger portion of the same molaris, preserved in spirit, showing the same circumstances as the preceding preparation.

130. A still larger portion of the same molaris, prepared in a similar manner. [The remaining part of the tooth is preserved among the fossil teeth of quadrupeds.]

"In the fossil bones of land animals, and those which inhabit the waters, as the sea-horse, otter, crocodile, and turtle, the animal part is in considerable quantity. In the stag's horns dug up in Great Britain and Ireland, when the earth is dissolved, the animal part is in considerable quantity and very firm. The same observations apply to the fossil bones of the elephant found in England, Siberia, and other parts of the globe; also those of the ox kind; but more particularly to their teeth, especially those from the lakes of America, in which the animal part has suffered very little."—"The state of preservation will vary according to the substance in which they have been preserved; in peat and clay I think the most; however, there appears in general a species of dissolution; for the animal substance, although tolerably firm, in a heat a little above 100° becomes a thickish mucus, like dissolved gum, while a portion from the external surface is reduced to the state of wet dust."

John Hunter, On Fossil Bones, ut supra, p. 415.

2. *Formation of Bone.*

a. *In Membrane.*

131. The carapace or dorsal shell of a very young Turtle (Chelonia Mydas), showing the state of ossification, which is continued from the margins of the ribs, at this period quite distinct from each other, until they meet and become joined by indented sutures similar to those of the cranium.

132. The cranium of a Fœtus (at about six months), showing the several places of commencement or centres of ossification, and the ossific matter deposited in fine bony fibres radiating therefrom.

b. *In Cartilage.*

132 A. The vertebral column of a Fœtus of the sixth month, injected, showing the commencement of ossification in the bodies and rings of the vertebræ.
Donor, William Lawrence, Esq. F.R.S.

132 B. The sternum of a Fœtus of the sixth month, injected, exhibiting the commencement of ossification by four separate points or centres: that of the manubrium, or first bone, has been removed from the cavity in which it was imbedded. *Mus. Heaviside, No.* 90.

133. The sternum and sternal extremities of the true ribs of a mature Fœtus. Four separate points of ossification may be observed in the sternum.

133 A. The pelvis of a (female) mature Fœtus, showing the radiating disposition of the ossific fibres in the ilium, and the separate points of ossification in the sacrum, ischium, and pubes. The coccyx is still wholly cartilaginous. *Donor,* Mr. Clift.

133 B. The femur of a mature Fœtus, showing the cartilaginous epiphyses; the superior of which comprehends the great and little trochanter.
Donor, Mr. Clift.

133 C. The tibia of a mature Fœtus, showing the cartilaginous epiphyses.
Donor, Mr. Clift.

133 D. A section of the foot of a mature Fœtus, injected, showing the cartilaginous condition of the bones of the tarsus, with the commencement of ossification in the os calcis and astragalus. *Prepared in* 1831.

The following preparations have been injected, dried, and preserved in oil of

turpentine, to show the vascularity of temporary cartilage during the progress of ossification therein.

134. The sternum of a Child at an early period of life, showing vessels from the internal mammary arteries, ramifying on the several separate ossifications.

135. The upper extremity of the tibia of a Child, having the patella attached. The arteries of the cartilaginous patella are injected, but ossification had not yet begun.

136. The patella of a Child more advanced in age, in which ossification has begun in the centre, and has extended along the coats of the arteries, making them appear like bony ramifications.

137. A series of three human patellæ of different periods of growth, to show the progress of ossification. This preparation also shows that the cartilage is not in fact extruded, but removed by the absorbents as ossification advances; and consequently that the increase in size of the whole patella is not in the ratio of the increase of the ossific deposition; as is exemplified in the lowest of the three patellæ.

138. A metatarsal cartilage of a Calf, injected. The points of the arteries in several parts are of a whitish colour, from a deposit of calcareous earth.

139. A section of the epiphysis of a metacarpal bone of the same animal, showing ossification beginning in several parts of the cartilage.

140. A similar preparation.

141. Another section, to show further progress of the ossification.

142. A section of the epiphysis of the shank-bone of a Calf, in which ossification is chiefly advancing from the centre.

143. A section of the epiphysis of a metacarpal bone of the same animal, injected; with a more distinct centre of ossification.

144. Another section, with the ossification more advanced.

145. The cartilage of an epiphysis, with the central ossification well injected, showing that it is much more vascular than the surrounding cartilage.

146. A similar preparation.

147. A similar preparation, with the ossification in its centre more advanced.

148. A section of temporary cartilage. The large vessel which traverses the preparation probably lies in the interspace of two adjoining epiphyses.

The following preparations have been injected, steeped in an acid, dried, and preserved in oil of turpentine, to show the vascularity of growing bone.

> " Parts whose use in the machine may be said to be passive, as tendon, cellular membrane, ligaments, investing membrane, bone, and cartilage, which last is probably the most passive, have all small vessels, and of course but few that are visible. As bone, however, is composed of two parts, viz. animal substance and earth, it is probable that there may be more action required to form the latter than either tendon or cartilage, and therefore there will be more vessels.
>
> " As a further proof that this is a general principle, we find that all growing parts are much more vascular than those that are come to their full growth; because growth is an operation beyond the simple support of the part: and this is the reason why young animals are more vascular than those that are full grown."—" This is known by injections, when parts are in the growing state, or are just grown, and for some time after." *Hunter, On the Blood*, 4to. 1794. p. 156.

149. A transverse section of the epiphysis of a cylindrical bone, which exhibits the progress of the vessels from the circumference towards the centre.

150. A transverse section of an epiphysis [probably from the leg of a fœtal Calf], the ossification of which is nearly completed.

151. A similar preparation.

152. A section of the metacarpal bone of a Calf.

153. A similar section of the metacarpal bone of a Calf.

154. A longitudinal section of the metatarsal bones of a Calf. Along the middle of this preparation may be observed the progress of the ossification, which afterwards produces a complete anchylosis, and reduces the two to a single cannon-bone.

155. A similar preparation; apparently a section of the preceding specimen.

156. The exterior section of the same bones. The vessels in the cartilaginous extremity are particularly distinct.

157. The two middle metatarsal bones of a Pig, sawed down. The vascularity is greatest at the spongy extremities.

158. A small section of bone, while in a growing state; apparently the outer crust of a tibia.

159. A similar preparation.

160. A longitudinal section of the tibia of a Calf.

161. A transverse section of the tibia of a young Man, exhibiting a much less degree of vascularity.

162. A section of the lower part of a human tibia, in which the degrees of vascularity of the epiphysis, the cancellous extremity, and denser part of the shaft of the bone may be compared with each other.

3. *Formation of Bone, exemplified in the Growth of the Horns of Deer.*

All the examples are from the Fallow Deer (Cervus Dama, *Linn.*).

163. A transverse section of part of the palm of the horn, while in a growing state, injected. The parts which invest the horn at this period are, a vascular membrane similar to periosteum and continued from the pericranium, cutis and cuticle continued from the integuments of the head, and a particular kind of short downy hair, which gives it a velvet appearance.

164. The extremity of the palm of the horn, while in a growing state, injected.

165. A transverse section of part of the palm of the horn, while in a growing state, injected; from which the outer velvet-like tegument has been removed, to show the vascular periosteal membrane, part of which is turned back.

166. A transverse section of part of the palm of the horn, while in a growing state, injected, to show its delicate cancellated structure, its vascularity at this period, and its periosteum, part of which is reflected from the bony substance.

167. A horizontal section of part of the palm of the horn, while in a growing

state, injected, and showing the same circumstances as the preceding preparation.

168. The outer layer of bone and the periosteal covering of part of the palm, and of one of the antlers of the growing horn, highly injected, and deprived of the earthy material by being steeped in acid, so that the ramifications of the vessels in the substance of the bone are more clearly shown. One of the external vessels of the periosteum derived from branches of the external carotid is also exposed.

"We find it a common principle in the animal machine, that every part increases in some degree according to the action required. Thus we find muscles increase in size when much exercised; vessels become larger in proportion to the necessity of supply, as for instance in the gravid uterus; the external carotids in the stag, also, when his horns are growing, are much larger than at any other time: and I have observed, that in inflammation the vessels become larger, more blood passes, and there appear to be more actions taking place; but the nerves do not seem to undergo any change. The nerves of the gravid uterus are the same as when it is in the natural state; neither do the branches of the fifth and seventh pair of nerves in the stag become larger."

Hunter, On the Blood, 4to. 1794, p. 288.

169. A section of an antler and part of the palm, injected, stripped of its periosteum, and steeped in an acid, to show the high degree of vascularity in the substance of the bone at this period of its growth.

170. The other section, or counterpart, of the preceding specimen.

171. A small portion of the palm taken from the same horn as the preceding specimen, and prepared in the same manner. It is extremely vascular.

The following seven preparations have been minutely injected, steeped in an acid, dried, and preserved in oil of turpentine, to show the vascularity of the substance of the growing horn.

172. A longitudinal section of an antler, in which the longitudinal disposition of the fibres may also be observed.

173. A similar specimen.

174. A similar specimen.

175. A transverse section of the palm of the horn, which gives to the internal structure a reticular appearance; in which part it may also be observed, that the blood-vessels are exceedingly minute, there being no large branches as on the external surface. See No. 168.

176. A similar specimen.

177. A small portion of the cancellated structure of the palm, cut in the direction of the fibres.

178. A section of the outer compact substance of the palm.

179. A section of part of the os frontis and of the base of a Deer's horn, of which the growth was nearly completed. It shows the horn to be a continuation of bone from the outer table of the skull, and the velvet-like covering of the horn to be equally continuous with the integuments of the head. It shows also the burr or pearl which has been formed round the base of the horn, and illustrates the effects of this part on the growth of the horn.

In the formation of the burr, which is the last part of the process, and takes place rapidly, the osseous tubercles of which it is composed are projected outwards, and, by their pressure, induce absorption of the vascular external covering, and increasing at the same time laterally, they inclose and compress the blood-vessels; thus in a short space of time the circulation is entirely obstructed, and consequently the whole of that once very vascular and sensible tegument loses its vitality, dries, shrinks, and peels off, leaving the horn a naked insensible weapon.

In one of the branches (the brow antler) in this preparation, the whole of the vessels appear to have been thus obliterated: in the other, a slight degree of vascularity remains, and one of the large external arterial branches is still uncompressed.

180. A section of part of the os frontis and base of the horn, which has been completely formed and divested of its external tegument, or burnished, as it is technically termed. This specimen has been injected, and steeped in an acid.

181. A section of part of the os frontis and base of the horn, injected and steeped in an acid, to show the connection of the horn with the skull the loose spongy texture in the centre of the bone, and the outer, compact, last-formed layer.

182. A slice of the same parts as the preceding preparation, showing the same circumstances.

183. A transverse section of the beam of the same horn as No. 181, injected and steeped in acid, "showing the two stages of growth, and its becoming cellular in the centre." [This is the original description in the manuscript Catalogue; but Mr. Hunter, unfortunately, has not left any commentary or further explanation of his ideas respecting this specimen.]

184. A similar preparation.

185. A similar preparation.

186. A section of part of the skull and base of the horn, a short time previous to its being shed; injected and steeped in an acid. It shows the commencement of the interstitial absorption at the root of the horn, which renders that part soft and yielding; and also the separation of the outer, last-formed, compact layer of bone from the internal spongy part.

187. A slice of the same parts as the preceding preparation, which exhibits more clearly the progress of the interstitial absorption at the base of the horn.

4. *Growth of Bone.*

188. The left tarsus of the domestic Fowl, upon which the following experiment was performed:—Two small holes were made by cauterization near the extremities of the bone; the length of the bone at that time being two inches and ten lines, and the distance between the holes one inch and eight lines. After a certain period the animal was killed, and the length of the bone was found to be three inches seven lines, while the space between the apertures was one inch and eleven lines; the increase of the bone beyond the points of cauterization being more than double that

of the space included between them. [The original note of the experiment is preserved in the bottle.]

189. The right tarsus of the domestic Fowl, longitudinally bisected, to show the results of the following experiment.—When the animal was young, the bone was perforated near each extremity, and a small leaden shot was introduced into each hole. After a certain period the animal was killed, and the length of the bone was found to have been increased to three inches and ten lines; but the distance between the shots, which had now reached the medullary cavity, was exactly the same as when first introduced. [The original note of the experiment is preserved in the bottle.]

—— "And here I must observe, that a bone does not grow in all its parts, that is, it does not grow by addition of new particles among those already arranged, or in their interstices, but by the addition of parts lengthways or sideways of the bone. This I proved by exposing the bones of young animals, and boring holes in them, which were prevented from being obliterated by fixing pieces of leaden shot in them: these bones were examined a considerable time after, when, although the bones had considerably grown, the holes were exactly at the same distance from each other." *John Hunter, MS. Lectures.*

The following preparations are from the common Hog (Sus domesticus), and are the results of experiments made by feeding that animal on the root of madder (Rubia tinctorum), but they have lost much of their original brightness of colour.

190. The skull of a young Pig, slightly tinged.

191. A larger skull, more strongly coloured.

192. The right side of the lower jaw, in which the ivory of the teeth has retained more perfectly the red colour, whilst the enamel is of its ordinary whiteness: [a circumstance which was remarked by Mr. Belchier, the discoverer of this property of madder.

See *Philos. Trans.* xxxix. 1736. p. 287.]

193. A longitudinal section of the humerus. [The counterpart is preserved dry. No. 748. *Osteological Catalogue.*] The madder appears to have been

remitted a short time before death, as there is a thin layer of uncoloured bone deposited on the external surface.

194. A longitudinal section of the ulna, probably from the same animal as the preceding.

195. A longitudinal section of a metacarpal bone, in which an external layer of uncoloured bone may be observed, as in No. 193, being probably part of the same animal.

196. The os innominatum, in which a very slight tinge remains.

197. A longitudinal section of the femur of the same Hog as No. 193.

In this preparation may be observed a very thin layer of uncoloured bone deposited on the exterior of the shaft after the madder was remitted, and also some of the original uncoloured bone which had not been absorbed from the interior of the shaft when the animal was killed.

[The counterpart of this preparation is preserved dry, No. 748. *Osteological Catalogue.*]

198. A longitudinal section of the femur of an older Hog, in which the layers of bone deposited before, during, and after the administration of madder are more distinctly observable. [This preparation is figured in an original drawing by Wm. Bell, Mr. Hunter's Assistant. *Cube* ii. *Drawer* i. No. 5.]

199. A longitudinal section of the femur of an older Hog, in which the coloured bone, deposited while the animal was under the influence of the madder, may be observed in some places to have reached the medullary cavity; the whole of the *originally exterior* uncoloured bone having been entirely absorbed at those parts.

200. A longitudinal section of the tibia of the same Hog as No. 193, [the counterpart of which is preserved dry, No. 748. *Osteological Catalogue*]. It exhibits the same circumstances as are described in Nos. 193 and 197.

201. A longitudinal section of the tibia of a younger Pig, with a thin exterior layer of coloured bone.

By comparing this specimen with, and observing the size of the medullary cavity in, the preceding, the extent of the absorbing process will

appear manifest; since the cavity is rendered sufficiently large to contain the entire bone of the earlier period of growth.

"In the formation of a bone, ossification begins in a spot, and gradually increases. By feeding an animal on madder, it is shown, that while bony matter is deposited on the outside of the bone, the absorbents are removing it from the inner side, otherwise the bone would become heavy and clumsy, and unfit for motion; therefore as the bony matter which was deposited becomes useless, nature removes it by the absorbents."

John Hunter, MS. Lectures.

See also "Experiments and Observations on the Growth of Bone, *from the Papers of the late Mr. Hunter*, by Everard Home, Esq. F.R.S.," in the *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, ii. p. 277. Read Oct. 4, 1798.

5. *Texture of Bones.*

a. *In Mammalia.*

202. A section of the bone of the tympanum of a Whale-bone Whale (Balæna mysticetus), which has been subjected to the action of an acid, and deprived of its earthy constituent. It exhibits a concentric laminated structure, and uniform solidity; the first formed central part not having undergone any change from the action of the absorbents, and no part exhibiting a trace of fibres, cancelli, or vessels.

203. Another section of the same bone, similarly treated, and exhibiting more distinctly the laminated texture.

"The bony part of the organ (of hearing) is very hard and brittle, rendering it even difficult to be cut with a saw, without its chipping into pieces. That part which contains the immediate organ is by much the hardest, and has a very small portion of animal substance in it; for when steeped in an acid, what remains is very soft, almost like a jelly, and laminated. The bone is not only harder in its substance, but there is on the whole more solid bone than in the corresponding parts of quadrupeds, it being thick and massy."

John Hunter, On the Structure and Œconomy of Whales, Philos. Trans. lxxvii. 1787. p. 432.

204. A section of the proximal extremity of the humerus of a young person, showing the reticular cancellous structure of the epiphysis, and of the extremity of the diaphysis of the bone.

205. The counterpart of the preceding preparation.

206. A section of the astragalus of a young person, exhibiting the reticular cancellous structure of the whole bone, the cancelli being largest in the centre.

207. The counterpart of the preceding preparation.

208. The os naviculare of a young person, longitudinally bisected, to show the cancellous structure nearly uniform throughout the bone.

209. The os cuneiforme internum of a young person, longitudinally bisected, and showing a similar structure.

209 A. A section of the diaphysis of a human tibia, injected; exposing the medullary cavity, and the secreting vessel of the marrow (Arteria medullaris), ramifying on the lining membrane of the cavity.

Donor, William Lawrence, Esq. F.R.S.

b. *In Birds.*

Showing the cavities of the bones which contain air.

210. The os humeri of an Owl (Strix ——— ? *Linn.*), which shows the cavity free from marrow, and cellular only at the extremities, and therefore a good receptacle for air. Near to the joint of the shoulder may be observed the aperture by which the air passes into the cavity.

"In most birds, I believe in all that fly, these axillary cells communicate with the cavity of the os humeri, by means of small openings in the hollow surface near the head of that bone: in some they are continued down the wing, communicating with the ulna and radius; in others they reach even as far as the pinions. The ostrich, however, is an exception:" [*i. e.* has no air even in the humerus.]

Hunter, On the Animal Œconomy, 4to. p. 92.

211. A longitudinal section of the ulna of the same bird as the preceding spe-

cimen, into which the air-cells are not continued, and which therefore exhibits the character of a cavity containing medullary matter.

212. A longitudinal section of the femur of the same bird, which has also had no connection with the air-cells, but contains medullary matter, and exhibits the difference between such bones and those which contain air.

[The bird from which the three preceding specimens were taken has evidently been injected, although the traces of vascularity in the humerus are extremely slight.]

"The bones which receive air are of two kinds; some, as the sternum, ribs, and vertebræ, have their internal substance divided into innumerable cells; whilst others, as the os humeri and the os femoris, are hollowed out into one large canal, sometimes with a few bony columns running across at the extremities. Bones of this kind may be distinguished from those that do not receive air, by several marks: 1st, by their less specific gravity; 2ndly, by being less vascular than the others, and therefore whiter; 3rdly, by their containing little or no oil, and consequently being more easily cleaned, and appearing much whiter when cleaned than common bones; 4thly, by having no marrow, nor a bloody pulpy substance, even in their cells; 5thly, by their not being, in general, so hard and firm as other bones; those of some birds are so soft, that they can be squeezed together with the finger and thumb; however, the bones of the extremities have very solid sides: 6thly, the passage by which the air gets into the bones can be easily perceived, even in cleaned bones. Generally there are several holes placed together near the end of the bone which is next the trunk of the bird; and distinguishable by having their external edges rounded off, which is not the case with those holes through which either nerves or blood-vessels pass into the substance of the bone."

An Account of certain Receptacles of Air in Birds, by John Hunter, F.R.S. Philos. Trans. lxiv. 1774. p. 205.

213. The os humeri of a Silk-fowl (Gallus lanatus, *Temm.*) longitudinally bisected, to show the cavity for containing air, and the passage by which it enters, which is indicated by a bristle.

" In the common fowl no air appears to enter any bone except the os humeri." *Hunter, On certain Receptacles of Air in Birds, ut supra,* p. 210.

214. A longitudinal section of two anterior dorsal vertebræ of an Ostrich (Struthio Camelus), showing the delicate reticular structure of the entire substance of these bones for receiving air, which enters by apertures near the roots of the transverse processes.

215. A section of the upper extremity of the femur of an Ostrich, showing its cellular structure for containing air. A bristle is passed through the aperture by which the air enters.

216. A section of the upper extremity of the femur of a young Ostrich, showing its cellular structure, and the aperture by which the air enters the cavity of the bone.

217. A section of the lower extremity of the femur of a young Ostrich, showing its cellular structure for containing air.

218. A section of the upper extremity of the tibia of a young Ostrich, showing the more compact cellular structure, containing medullary matter; and the epiphysis.

219. A section of the lower extremity of the tibia of a young Ostrich, showing the more compact cellular structure, and the medullary cavity.

6. *Ossification by Excretion*.*

220. A section of the tusk and part of the jaw of a Boar, exposing the pulp, upon and from which the tooth is formed. The parts have been steeped in an acid, so as to remove the enamel and earthy constituent of the tooth.

* This Title is made to precede No. 220 $\left(\frac{1}{5\,a}\right)$ in the original MS. Catalogue, but without any comment or further explanation. Mr. Hunter's opinions respecting the Growth of Teeth are, however, fully set forth in his work on the Teeth, and there are numerous preparations in illustration thereof in the series appropriated to the subject. The preparation of the Boar's tooth appears to have been placed here chiefly to show the difference between Ivory and Bone, in Structure and Mode of Growth.

"*Of the Bony Part of a Tooth.*

"The other substance of which a tooth is composed is bony, but much harder than the most compact part of bones in general. This substance makes the interior part of the body, the neck, and the whole of the root of a tooth. It is a mixture of two substances, viz. calcareous earth and an animal substance, which we might suppose to be organized and vascular. The earth is in very considerable quantity; it remains in the same shape after calcination, so that it is in some measure kept together by cohesion, and it is capable of being extracted by steeping in the muriatic and some other acids. The animal substance, when deprived of the earthy part, by steeping in an acid, is more compact than the same substance in other bones, but still is soft and flexible."

Hunter, On the Teeth, 4to. 1778, p. 36.

Series X. Situation of the Skeleton.

1. *External.*

221. The shell of a Limpet (Patella deaurata, *Lam.*).

2. *Internal.*

222. The calcareous plate of a Cuttle-fish (Sepia officinalis) [See also Nos. 105, 106.]

3. *Mixed.*

223. A section of the claw of a Lobster (Astacus marinus), where part of the skeleton is thrown inwards for the insertion of muscles. [See also Nos. 60, 61.]

224. A section of the Hercules Beetle (Dynastes Hercules, *Macleay*), showing the processes which are sent inwards from the external integument.

[The principal processes given off from the upper part of the trunk or *Thorax*, are the *prophragma*, the *mesophragma*, and the *metaphragma*, from which the muscles of the wings arise, and others that move the

segments of the body. Of those given off from the under part of the body or Pectus, are the *antifurca*, *medifurca*, and *postfurca*, which serve as points of attachment to the muscles that move the legs.

See *Kirby and Spence, Introd. to Entomology*, iii. p. 581.]

Series XI. Composition of the Skeleton.

1. *Skeleton composed of One Piece.*

225. The horny elongated plate of Loligo vulgaris, *in situ.*

226. A section of the calcareous plate of Sepia officinalis.

2. *Skeleton composed of Several Pieces unattached.*

227. A Sea-pen (Pennatula grisea, *Bohadsch.*), laid open along the anterior aspect to expose the single bony stem running along the whole centre; and the spines going off laterally, but not attached to the central stem.

228. A longitudinal section of Pennatula grisea, exhibiting the structure of the central stem.

229. A longitudinal and transverse section of Pennatula grisea, exposing the central stem and its membranous theca, and also the origins of the lateral spines.

3. *Elastic Joints.*

Joints are the different configurations given to the ends of those substances, whatever they may be, on which the animal is to have motions produced, and the adaptation of those surfaces together so as to allow of easy motion. These will always vary according to the strength or quantity of motion required in the joint; and as the two are incompatible with each other, preference must always be given to one or the other according to circumstances. *Hunterian MS. Catalogue.*

230. A portion of the spine of the glutinous Myxine or Hag (Gastrobranchus cæcus, *Bloch.*], in which all distinction of the bodies of the vertebræ is lost, and the whole spine is composed of a fibrous capsule surrounding a single cylindrical gelatinous or soft cartilaginous body.

230 A. A portion of the River Lamprey (Petromyzon fluviatilis, *Linn.*), in which is exposed the cylindrical gelatinous mass occupying the situation of the bodies of the vertebræ. *Prepared in* 1831.

230 B. A portion of the spine, with the head, of a River Lamprey, showing the cartilaginous part which surrounds the spinal chord, and in which the vertebral rings are indicated. In the transverse sections may be observed the relative situations of the cartilaginous and gelatinous parts of the spine. *Prepared in* 1831.

230 C. A portion of the spine of a Sea Lamprey (Petromyzon marinus, *Linn.*), showing the cartilaginous and gelatinous parts, and their mode of connection with the head: the latter substance is connected by gomphosis with the occipital cartilage. *Prepared in* 1831.

231. A transverse section of the spine of a Sturgeon (Acipenser Sturio, *Linn.*), showing the cylindrical fibrous capsule inclosing the gelatinous body analogous to the spines of the Myxine and Lamprey, and the external investing cartilaginous substance in which the vertebral rings are slightly indicated, and the spinous processes and rudiments of the transverse processes are distinctly developed.

232. A portion of the internal gelatinous substance from the spine of a Sturgeon. A longitudinal section has been made on one side, which exposes some small cavities in the centre.

233. A longitudinal section of a part of the same substance, exposing a larger central cavity.

234. A transverse section of the spine of a Sturgeon, showing the internal gelatinous and membranous substance, and the external cartilaginous parts; also the circular canal above the bodies of the vertebra, which contains the spinal chord, and the transverse canal beneath, for the passage of the large blood-vessels. There may be also observed a space above the canal of the spinal chord, formed by the divarication of the cartilaginous pieces which constitute the summits of the spinous processes of the vertebræ. This is filled by fibro-cartilaginous substance connecting the processes in question.

235. A longitudinal section of the spine of a Sturgeon, which shows the indistinct character of the division of the vertebral pieces. The whole spine being composed of very elastic materials, renders the existence of joints almost unnecessary.

236. A vertical section of the spine of a Sturgeon, showing the ligamentous connection of two portions thereof.

237. A portion of the spine of a Shark (a small species), longitudinally bisected, to show the external cartilaginous part of a firmer texture than in the sturgeon, and divided into distinct vertebræ, which are joined to each other by elastic ligamentous capsules, attached to the base of hollow cones formed in the bodies of contiguous vertebræ.

237 A. A longitudinal section of part of the spine, from near the middle of the abdomen, of the Basking Shark (Squalus maximus, *Linn.*), exhibiting the cavities of two intervertebral capsules. These are tensely filled, in the living state, with a transparent fluid resembling lymph, which, from the elasticity of the surrounding capsule, is thrown out to a considerable distance when the cavity is opened. The internal projection of the capsule is partly owing to the infiltration of fluid between the laminæ of which it is composed, and partly occasioned by the superincumbent weight of the vertebræ before the parts had been sufficiently hardened in spirit. *Prepared by Mr. Clift. Presented by Sir E. Home, Bart.*

237 B. A longitudinal section of part of the spine of the Basking Shark, made after sufficient maceration in spirit, and in which, consequently, the natural form of the intervertebral cavity is better preserved.

Prepared by Mr. Clift. Presented by Sir E. Home, Bart.

238. A longitudinal section of five vertebræ of a Cod-fish (Gadus morrhua), exhibiting intervertebral cavities of the same form as in the shark, but which are filled, as in all osseous fishes, with a more consistent gelatinous substance.

239. The counterpart of the preceding preparation.

4. *Joints, with Ligamentous Fibres attached to the whole of the Articular Surface.*

240. A section of the ligamentous substance which unites the lower jaw to the cranium in the Whale.

"The articulation of the lower jaw is not by simple contact either single or double, joined by a capsular ligament, as in the quadruped; but by a very thick intermediate substance of the ligamentous kind, so interwoven that its parts move on each other, in the interstices of which is an oil. This thick matted substance may answer the same purpose as the double joint in the quadruped."

Hunter, On the Structure and Œconomy of Whales, Philos. Trans. lxxvii. 1787, p. 384.

240 A. The left ramus of the lower jaw, and part of the cranium of a Porpesse (Phocæna communis). A section has been made through the joint, to show the fibrous connecting substance *in situ.* *Prepared in* 1831.

241. A longitudinal section of two caudal vertebræ of a Horse, and their connecting concentric ligaments, the fibres of which are seen passing between the whole of the articular surfaces in a direction perpendicular to the planes of those surfaces.

242. The corresponding section or counterpart of the preceding preparation. These vertebræ form a remarkable contrast to those of fishes, as they present to each other convex, instead of concave, surfaces.

243. A single vertebra from the tail of a Horse, exhibiting a transverse section of the intervertebral substance, the ligamentous fibres of which are disposed in concentric circles, which recede from each other as they approach the centre, and have a glairy fluid in the interspaces.

244. A transverse section of the intervertebral substance of the caudal vertebra of a Horse.

245. A transverse section of the intervertebral substance of the Bottle-nose Whale (Delphinus Dalei, *Fred. Cuvier*). *Hunter, On the Whale, Philos. Trans.* lxxvii. 1787. *tab.* xix. *Catalogue, Osteological Division, No.* 1145.

It is six inches in diameter: the external half inch appears of uniform

consistency, and exhibits very little of the fibrous character. The rest of the substance, to within an inch of the centre, is composed of ligamentous fibres arranged in concentric circles, and at nearly equal distances: the remaining central part appears to be wholly occupied by coagulated glairy matter.

246. A longitudinal and vertical section of two vertebræ of a Siren (Siren lacertina, *Linn.*). The articular surfaces of the bodies of the vertebræ are hollowed out as in fish, but the cavities are occupied by ligamentous fibres disposed in concentric circles: the oblique processes are joined by capsular and synovial membranes.

247. *The vertebral column of a mature Fœtus, from which the ligamentum commune anterius has been removed, to show the intervertebral substances, which are composed of concentric ligamentous fibres, passing between and connecting the whole of the articular surfaces of the bodies of the vertebræ, as is exhibited in the preceding specimens. The oblique processes are connected by another mode of articulation [see the following sub-series], where opposed cartilaginous articular surfaces are simply in contact, being connected to each other by a capsular ligament and synovial membrane.

247 A. The vertebral column of a Child, showing the same circumstances as the preceding preparations. The capsule connecting the atlas and dentata is preserved and laid open on the right side, showing its laxity, so as to allow of the rotatory motions between these vertebræ.

248. A longitudinal and vertical section of the cervical vertebræ of a Turtle (Chelonia Mydas), the bodies of which (with the exception of the first three) are connected by ligamentous substance passing between the whole of their articular surfaces. These surfaces, in the second, third, and fourth vertebræ, are convex at the anterior part, and concave at the posterior; in the fifth they are concave at both aspects; the anterior

* This and the preceding preparation formed a distinct groupe, in the original Catalogue, with the title, "Articulation with Broad Surfaces and Capsular Ligaments," in allusion to the two kinds of joints, viz. between the bodies and the oblique processes of the vertebræ.

surface of the sixth is concave, the posterior plane; both surfaces are plane in the seventh; but the posterior surface of the eighth vertebra is convex.

5. *Joints with Synovia and Capsular Ligaments.*

249. A longitudinal and vertical section of the cervical vertebræ of a Tortoise, in which the motions of the neck are much freer than in the Turtle; the articular surfaces of the bodies of the vertebræ being covered by cartilage, and surrounded by synovial membrane. The anterior surfaces of the first three vertebræ are convex, the posterior concave. The fourth vertebra, which is the principal centre of motion in the neck, has both the articular surfaces convex. Of the remainder the anterior surfaces are concave, the posterior convex. The canal of the spinal chord may be observed to be the widest, where the motion in this part of the spine is most extensive.

250. A longitudinal and vertical section of the vertebral column of an Alligator (Crocodilus lucius, *Cuv.*). The vertebræ are for the most part united by a species of enarthrosis, or ball-and-socket joint; the anterior surface being concave, the posterior convex. The exceptions occur in the atlas and dentata; in the sacral vertebræ, which are articulated together by plane surfaces; and in the first caudal vertebra, which has both its articular surfaces convex.

250 A. A longitudinal and vertical section of the anterior part of the vertebral column of a large Serpent (Python Tigris, *Daudin.*). The bodies of the vertebræ are joined by a very regular and complete enarthrosis; the posterior part of each vertebra presenting a smooth hemispherical tubercle, which is received into a corresponding cavity in the anterior part of the vertebra that succeeds it. *Prepared in* 1831.

250 B. The counterpart of the preceding preparation. *Prepared in* 1831.

250 C. A longitudinal and transverse section of the bodies of the vertebræ of a large Serpent (Python Tigris, *Daudin.*), exhibiting the forms of their articular surfaces. *Prepared in* 1831.

251. A longitudinal section of two cervical vertebræ of an Ostrich, exposing the cavity of the ball-and-socket joint which unites these vertebræ; but here, the anterior surface is convex, the posterior concave.

252. A longitudinal section of two anterior dorsal vertebræ of the Ostrich, the bodies of which are articulated by a capsular ligament, as in the preceding specimen, but the articular surfaces approach nearer to a ginglymoid joint.

The canal for the passage of the medulla spinalis is enlarged near the articulation, to prevent its being compressed in the motions of that part of the spine.

253. A dorsal vertebra, and the vertebral extremity of a rib of an Ostrich, showing that the latter is articulated by distinct capsular ligaments to two different points of the vertebra; viz. the anterior part of the body, and the transverse process. The orifice for the admission of air into the rib may be observed in the angle of the neck and tubercle.

254. A portion of the sternum and the sternal extremity of the rib of an Ostrich, showing that this part is also articulated by distinct capsules to two points of the sternum. The sternal and vertebral portions of the rib are also articulated by a synovial capsule.

255. The parts constituting the left human shoulder-joint. The capsular ligament is laid open to expose the head of the humerus, and the tendon of the long head of the biceps muscle passing along the upper part of the articular cavity, and attached to the marginal ligament of the glenoid cavity of the scapula. The section of the capsular ligament shows its relative thickness at the upper and lower part.

255 A. The os innominatum and femur of a large Tortoise (Testudo Indica, *Vosmaer.*). The hip-joint is laid open to show that the ligamentum teres is deficient. This simple form of joint obtains at the hip in all the Chelonian reptiles. *Prepared and Presented by Mr. Clift.*

255 B. The left os innominatum and femur of a Seal (Phoca vitulina, *Linn.*). The capsule of the hip-joint is partly removed, and the head of the thigh-bone turned out of the cotyloid cavity, showing it to be quite smooth,

without any depression for a ligamentum teres, which is deficient in this animal*: the cotyloid cavity has, however, the usual notch and depression, the latter being filled with the fatty membranous substance called *Gland of Havers.* *Prepared in* 1831.

255 C. The right os innominatum, os marsupiale, and posterior extremity, with a section of the lumbar, sacral, and part of the caudal vertebræ of the Ornithorhynchus Paradoxus. The anterior part of the capsule of the hip-joint is turned down, to expose the head of the thigh-bone, and the cotyloid cavity, and to show that the ligamentum teres is deficient also in this species. *Prepared in* 1831.

255 D. The right os innominatum, os marsupiale, and femur, of the Echidna Hystrix. The capsule of the hip-joint is turned down, and the head of the femur turned out of the cotyloid cavity, to show a similar deficiency of the ligamentum teres. There are two slight depressions in the middle of the cartilage covering the head of the femur, which may have been produced by pressure against the sides of the foramen at the back part of the cotyloid cavity, which is deficient at that part, as it is in birds. *Prepared in* 1831.

255 E. The head of the right femur of an Elephant (Elephas Indicus, *Cuv.*), three years old. The cartilaginous articular surface is uniformly smooth, having no depression for the insertion of the ligamentum teres, which is deficient in the hip-joint of this species also. *The animal purchased.*

255 F. The head of the left femur of the same animal. *The animal purchased.*

255 G. The right os innominatum and femur of the three-toed Sloth (Bradypus tridactylus, *Linn.*). The hip-joint is laid open to show a similar deficiency of the ligamentum teres. *Prepared in* 1831.

255 H. The right os innominatum and femur of the two-toed Sloth (Bradypus didactylus, *Linn.*). The hip-joint is laid open to show a similar deficiency of the ligamentum teres. *Prepared in* 1831.

* On examining the head of the thigh-bone in another species of Seal, and in the Walrus, no depression for ligamentum teres was found, and most probably it is deficient in all this tribe.

255 I. The left os innominatum and upper part of the femur, with a section of the lumbar, sacral, and coccygeal vertebræ of an Orang Utan (Simia Satyrus, *Linn.*). The hip-joint is laid open, and the head of the thigh-bone dislocated and turned forwards, to show its smooth and uniform spherical articular surface, having no depression for a ligamentum teres, which is deficient also in this species.

[The Simia Satyrus exhibits but little agility while in captivity, and is seldom observed to go on all fours after the manner of quadrupeds, or the inferior Simiæ; but in using its long arms in progressive motion on the ground, it supports itself on the bent fingers as on a pair of crutches, and swings the body forward between them. The diminutive lower extremities appear to be especially destined for the actions of grasping and climbing, and are by no means calculated to support the body erect. The flexor muscles of the fingers of the hinder hands have also some peculiar modifications in their origins and insertions, which well adapt them for grasping objects: thus, the muscle analogous to the Flexor longus pollicis pedis has its origin extended above the knee-joint to the outer condyle of the femur, in the same manner as the Flexor sublimis of the upper extremity passes over the elbow-joint and arises from the humerus: like it also, the above-named muscle in the lower extremity sends no tendon whatever to the thumb, but is inserted exclusively into the fingers, being limited however to the third and fourth, which are the longest fingers of the hinder hand. This disposition of the flexor muscles of the fingers, together with the simplicity of the hip-joint, add considerably to the analogy between the upper and lower extremities in this quadrumanous animal.] *Prepared in* 1831.

6. *Joints with Capsular and Interarticular Ligaments.*

255 K. The right anterior extremity of a large Frog (Rana ——? *Laurenti*). The shoulder-joint is laid open, and the capsule turned back, to show an interarticular ligament, passing from a depression in the head of the humerus to a depression in the centre of the glenoid cavity, and attached also to the inferior margin of that cavity. A bristle is passed behind this

ligament: a small synovial bag projects into this joint just above the insertion of the ligament.

This additional security against dislocation of the shoulder-joint appears to be necessary in the frog, to obviate the effects of the shock, or impulse, which the anterior extremities receive when the animal alights from a leap. *Prepared in* 1831.

256. The parts constituting the human hip-joint of the right side. The anterior part of the capsular ligament is turned back to show the extent to which the synovial membrane is reflected over the anterior part of the neck of the thigh-bone; the thickness of the ligamentous part of the capsule is also shown by the section.

In the cotyloid cavity may be observed the ligamentum teres, round which a bristle is tied, and the depression containing the fatty and synovial substance commonly called the Gland of Havers.

257. A dorsal vertebra, and the articular extremities of four ribs of a Horse. These are attached by capsular ligaments to the angles of the body of the vertebra; they have also a strong transverse ligament which passes from the head of one rib, behind the intervertebral substance, to the head of the opposite rib; thus connecting them firmly to each other, and to the vertebra.

7. *Joints with Capsular Ligaments, and Interarticular Substances for the adaptation of the different parts of the Joint to one another.*

258. A vertical and longitudinal section of part of the lower jaw and temporal bone of a young Lion, exhibiting the interarticular substance extending through the whole of the joint, and dividing it into two synovial cavities.

259. The corresponding section of the same parts, showing the same circumstances.

260. A vertical and transverse section of part of the lower jaw and temporal bone of a Lion, showing the extent of the joint in that direction and the form of the interarticular substance, convex from side to side above, concave below.

261. A section through the temporal bone and condyle of the lower jaw of a Beaver (Castor Fiber, *Linn.*), giving a posterior view of the double articular cavity and intermediate substance; and showing that the capsular ligament between the interarticular substance and glenoid cavity is longer than that between the interarticular substance and condyle of the lower jaw; both of which, therefore, in extensive motions of the jaw backwards and forwards, must move together upon the temporal bone.

262. The interarticular ligamentous substance from the joint of the lower jaw of the Elephant. The surface adapted to the temporal bone is concave in the lesser and convex in the larger diameter: the opposite or lower surface presents a deep, oval excavation for the reception of the condyle of the jaw.

263. A vertical section of the interarticular substance from the joint of the lower jaw of a younger Elephant, showing the degree of concavity on each side, so well calculated for adapting two convex surfaces to each other. A bristle is placed in an orifice leading out of the lower cavity, which is probably the duct of a gland.

264. The counterpart of the preceding preparation, divided horizontally, and exhibiting a disposition of the outer ligamentous fibres in concentric circles, similar to the intervertebral substances of the spine.

265. A vertical section of part of the temporal bone and ramus of the lower jaw of a human subject, exhibiting the forms of the temporal and condyloid articular cavities, and of the intermediate fibrous cartilage.

"Just under the beginning of the zygomatic process of each temporal bone, before the external meatus auditorius, an oblong cavity may be observed; in direction, length, and breadth, in some measure corresponding with the condyle of the lower-jaw. Before, and adjoining to, this cavity, there is an oblong eminence placed in the same direction, convex upon the top in the direction of its shorter axis, which runs from behind forwards; and a little concave in the direction of its longer axis, which runs from within outwards. It is a little broader at its outer extremity, as the outer corresponding end of the condyle describes a larger

circle in its motion than the inner. The surface of the cavity and eminence is covered with one continued smooth cartilaginous crust, which is somewhat ligamentous, for by putrefaction it peels off, like a membrane, with the common periosteum. Both the cavity and eminence serve for the motion of the condyle of the lower-jaw. The surface of the cavity is directed downward; that of the eminence downward and backward, in such a manner, that a transverse section of both would represent the italic letter *f*. Though the eminence may, on a first view of it, appear to project considerably below the cavity, yet a line drawn from the bottom of the cavity to the most depending part of the eminence is almost horizontal, and therefore nearly parallel with the line made by the grinding surfaces of the teeth in the upper-jaw; and when we consider the articulation farther, we shall find that these two lines are so nearly parallel, that the condyle moves almost directly forwards in passing from the cavity to the eminence; and the parallelism of the motion is also preserved by the shape of an intermediate cartilage.

"In this joint there is a moveable cartilage, which, though common to both condyle and cavity, ought to be considered rather as an appendage of the former than of the latter, being more closely connected with it, so as to accompany it in its motion along the common surface of both the cavity and eminence. This cartilage is nearly of the same dimensions with the condyle, which it covers; is hollowed on its inferior surface to receive the condyle: on its upper surface it is more unequal, being moulded to the cavity and eminence of the articulating surface of the temporal bone, though it is considerably less, and is therefore capable of being moved with the condyle from one part of that surface to another. Its texture is ligamento-cartilagineous. This moveable cartilage is connected with both the condyle of the jaw and the articulating surface of the temporal bone, by distinct ligaments, arising from its edges all round. That by which it is attached to the temporal bone, is the most free and loose; though both ligaments will allow an easy motion, or sliding of the cartilage on the respective surfaces of the condyle and temporal bone. These attachments of the cartilage are strengthened, and the whole articulation secured, by an external ligament, which is

common to both, and which is fixed to the temporal bone, and to the neck of the condyle. On the inner surface of the ligament, which attaches the cartilage to the temporal bone, and backwards, in the cavity, is placed what is commonly called the gland of the joint; at least, the ligament is there much more vascular than at any other part."

Hunter, On the Teeth, 4to. 1st edit. 1771. p. 9.

8. *Joints with Capsular and Interarticular Ligaments, and Interarticular Substances.*

265 A. The parts constituting the human knee-joint. The patella and part of the capsule are turned down to show the ligamentum adiposum within the joint and the anterior crucial ligament; the extent of the synovial membrane and the line of its reflection upon the condyles of the femur: the capsule is removed from the posterior part of the joint to show the interarticular semilunar cartilages and the posterior crucial ligament. The lateral ligaments and part of the tendon of the popliteus are also shown. *Prepared in* 1831.

266. The interarticular semilunar cartilages from the human knee-joint, injected; showing their transverse connecting ligaments, and the different character of the upper and lower parts for adapting a convex to a flat surface.

267. A portion of the lower articulating extremity of a human femur, showing the fibrous structure of the articular cartilage, and the direction of the fibres perpendicular to the surface from which they arise.

268. Another section of the same bone and cartilage, showing the same circumstances.

"An articulating cartilage is an elastic substance, uniformly compact, of a white colour, and somewhat diaphanous, having a smooth polished surface covered with a membrane; harder and more brittle than a ligament, softer and more pliable than a bone.

"When an articulating cartilage is well prepared, it feels soft, yields to the touch, but restores itself to its former equality of surface when the pressure is taken off. This surface when viewed through a (magni-

fying) glass, appears like a piece of velvet. If we endeavour to peel the cartilage off in *lamellæ*, we find it impracticable; but if we use a certain degree of force, it separates from the bone in small parcels, and we never find the edge of the remaining part oblique, but always perpendicular to the subjacent surface of the bone. If we view this edge through a glass, it appears like the edge of velvet; a mass of short and nearly parallel fibres rising from the bone, and terminating at the external surface of the cartilage; and the bone itself is planned out into small circular dimples, where the little bundles of the cartilaginous fibres were fixed. Thus we may compare the texture of a cartilage to the pile of velvet, its fibres rising up from the bone as the silky threads of that rise from the woven cloth or *basis*. In both substances the short threads sink and bend in waves upon being compressed; but by the power of elasticity, recover their perpendicular bearing as soon as they are no longer subjected to a compressing force. If another comparison were necessary, we might instance the flower of any corymbiferous plant where the *flosculi* and *stamina* represent the little bundles of cartilaginous fibres; and the calyx upon which they are planted bears analogy to the bone.

"Now these perpendicular fibres make the greatest part of the cartilaginous substance; but without doubt there are likewise transverse fibrils which connect them, and make the whole a solid body, though these last are not easily seen, because being very tender, they are destroyed in preparing the cartilage.

"We are told by anatomists, that cartilages are covered with a membrane named *Perichondrium*. If they mean the cartilages of the ribs, *larynx*, ear, &c. there indeed such a membrane is very conspicuous; but the *perichondrium* of the smooth articulating cartilages is so fine, and firmly braced upon the surface, that there is room to doubt whether it has been often demonstrated or rightly understood.

"This membrane, however, I have raised in pretty large pieces after macerating, and find it to be a continuation of that fine smooth membrane that lines the capsular ligament, folded over the end of the bone from where that ligament is inserted. On the neck of the bone, or between the insertion of the ligament and border of the cartilage, it is

very conspicuous, and may be pulled up with a pair of pincers; but where it covers the cartilage, it coheres to it so closely, that it is not to be traced in the recent subject without great care and delicacy. In this particular it resembles that membrane which is common to the eye-lids and the fore part of the eye-ball, and which is loosely connected with the *Albuginea*, but strongly attached to the *Cornea*.

"From this description it is plain that every joint is invested with a membrane which forms a complete bag, and gives a covering to everything within the articulation, in the same manner as the *Peritonæum* invests not only the *Parietes* but the contents of the *Abdomen*."

"*On the Structure and Diseases of Articulating Cartilages, by William Hunter, Surgeon*" (afterwards M.D.). *Philos. Trans.* xlii. 1742—3, *page* 514.

269. The parts constituting the knee-joint of a Calf. The patella is turned down, to expose the anterior part of the joint; and on the opposite side the capsular ligament is removed, to show the intervening semilunar cartilages and crucial ligaments. This joint has in this animal a septum extending across it (apparently a greater developement of what is called Ligamentum adiposum in the human subject), which divides it into an anterior and posterior cavity.

270. A vertical section of the parts constituting the knee-joint of the same animal, showing the intermediate substance which unites the femur and tibia, producing a distinct anterior cavity between the patella and condyle of the femur, and a posterior one between the condyle and head of the tibia.

271. The counterpart of the preceding preparation.

271 A. The parts constituting the knee-joint of the Ornithorhynchus paradoxus. The articular cavity is divided into two compartments by a continuation and extension of the ligamentum adiposum from the back of the patella to the crucial ligaments; there being one synovial cavity common to the patella and anterior part of the femur, with the internal condyle and tibia, containing the internal semilunar cartilage; and a second common

to the external condyle of the femur and tibia, with the head of the fibula, in which is contained the external semilunar cartilage.

Prepared in 1831.

272. The parts constituting the knee-joint of an Ostrich, injected. A section has been made through the patella, and the anterior part of the joint is laid open to show the crucial ligaments, and a very large tendon passing through the joint to be attached to the front of the external condyle: also a tendon passing through a synovial sheath in the ligament of the patella, in an oblique direction from the femur to the tibia. Posteriorly, the capsular ligament is removed, to show the semilunar cartilages and the ligament connecting the external one to the head of the fibula, which in this class of animals is articulated with the external condyle of the femur, and forms part of the knee-joint.

The blood-vessels upon the inner condyle are successfully filled, and exhibit numerous mutual anastomoses as they approach the articular cartilage, forming what Dr. Hunter termed "the *Circulus Articuli vasculosus;* the vascular border of the joint."

Series XII. Mechanical Contrivances by which the Powers of the Muscles are augmented.

"In the formation of many parts of the body, neatness is a principal object, as is visible not only in the external form of the limb, but in the parts constructed for motion; as in the formation of the bones and their situation with respect to one another, and the mode of removing the inserted tendon (when too close to the centre of motion to produce a sufficient effect) a little further off, by means of little moveable bones called Patellæ, or Sesamoid bones, as in the knee, first joints of the thumb, and great toe: and where this construction would be clumsy and inconvenient, as in the fingers and lesser toes, the two tendons which are obliged to pass along these parts to their insertions at the second and third joints, are so disposed in their course, that the profundus, or one

nearest to the bone, acts as a patella to the other, keeping it at a distance from the centre of motion equal to its own thickness; and the sublimis, or upper one, is obliged to split into two, near its termination, before it can be inserted into the second bone. The advantage gained by this construction is, that the tendon of the muscle employed in the greatest action is removed further from the centre of motion than it otherwise could be, and from which the other sustains no disadvantage."

John Hunter, MS. Croonian Lectures.

1. *By the Mode of Insertion.*

273. A vertical section of the articular extremities of the human humerus and ulna, showing the trochlea of the former bone to which the articular cavity of the latter is adapted, and the mode in which the power of the triceps brachii is increased by the projection of the olecranon, its point of insertion, beyond the centre of motion.

273 A. A vertical section of the foot of a child, showing the insertion of the tendo Achillis at the inferior part of the os calcis, a bursa mucosa being interposed as it passes over the back part of the same bone.

Prepared in 1831.

2. *By the Interposition of Tendons and Ligaments.*

273 B. The middle finger and a longitudinal section of the fore finger of the human subject. In the former the flexor tendons are exposed, to show the perforans tendon acting as a patella to the perforatus as it passes over the first joint of the finger, and being itself removed from the centre of motion by the interposition of the perforatus tendon at the second joint. In the section of the index finger may be observed an additional contrivance for the same purpose, viz. the interposition of a ligamentous substance at the second and third joints, between the flexor tendons and the centres of motion. *Prepared in* 1831.

274. Portions of tendons from an Ostrich, showing two passing through a sheath formed by a third; which, intervening between them and the

centre of motion, acts as a patella to them, in the manner exhibited in the preceding preparation.

275. The parts constituting the tarsal joint of an Ostrich. The flexor tendons of the toes pass through a sheath in the extensor tendon of the tarsus, which is considerably thickened at that part; and while it securely retains them in their proper situation, removes them further from the centre of motion at that joint, and augments the lever of the moving power.

276. A vertical section of the metatarsal bone and phalanges of the greater toe of an Ostrich, and of their flexor tendons. Each bone has its proper tendon inserted into it, which forms a sheath for the tendon of the succeeding phalanx: and on the plantar aspect of each joint is situated a ligamentous substance (analogous to those in the human finger), forming part of that joint, and playing on an articular surface in the lower extremity of the superior bone. These act like patellæ, removing the flexor tendons further from the centres of motion of their respective joints, and forming so many elastic cushions to protect the joints, and obviate the effects, by diffusing the forces of pressure and percussion.

276 A. The hinder extremity of a large Frog (Rana ———? *Laurenti*), showing that the muscles which flex the tarsus arise from the front part of the condyle of the femur, and pass over the knee-joint. A large bristle is placed under the tendon of the tibialis anticus. These tendons serve, in some degree, to remove the extensor tendon of the leg from the centre of motion, for it contains neither a patella nor sesamoid bone in this order of animals. *Prepared in* 1831.

276 B. The anterior extremity of the same animal as the preceding, showing that the tendon of the extensor cubiti is thickened as it passes over the elbow-joint; that it plays on a convexity at the lower and back part of the humerus, and acts as a substitute for the olecranon. *Prepared in* 1831.

3. *By means of Sesamoid Bones.*

276 C. The anterior extremity of a Surinam Toad (Rana Pipa, *Linn.*), showing

a sesamoid bone interposed like a patella between the tendon of the extensor cubiti and the elbow-joint. *Prepared in* 1831.

277. A vertical section of the human tibia and patella, and of the tendon of the extensors of the leg, showing the distance to which the tendon is removed from the centre of motion by the interposition of the latter bone.

278. The corresponding section of the same parts. These sections also show the mode of attachment of tendons to bone; not immediately into the substance of the bone, but into the periosteum.

279. A vertical section of the fore foot of a Horse, in which are illustrated all the preceding contrivances for augmenting the moving powers, and diffusing the concentrated forces of pressure and percussion. To attain the first of these purposes, the posterior projecting process of the small pastern bone, like an olecranon, affords a more advantageous insertion to the flexor perforatus, the tendon of which acts also as a patella to the tendon which passes behind it; and this again has the sesamoid or nut-bone (os naviculare) interposed between it and the last joint, before it is ultimately inserted into the coffin-bone or terminal phalanx:—for the second purpose may be observed the interposition of that peculiar substance called the *fatty frog*; and the disposition of the fibres of the hoof, like those of articulating cartilage, perpendicular to the direction of the compressing forces.

Series XIII. The various Organs for Progressive Motion.

—— "I may be allowed to observe, previous to entering upon the mechanical motions produced by the muscles in an animal body, that, without resistance, the progressive motions of animals could not take place; for although a muscle has the power of contracting in itself, and is capable of moving all its different parts upon itself, it cannot, however, move any other part without having a fixed point to move from, which must be the greatest point of resistance. There is a fixed point, therefore, in every animal, from which the parts of the body take their principal

motions. This point, in the human body, seems to be the joints of the thigh bones; which point, being in the middle of the body, must be common to the extremities. We see, therefore, that the body either moves upon the legs, or the legs move on the body or trunk: besides this there are many other fixed points; so that the body is to be looked upon as a chain of joints, whose general centre of motion is in the joints of the thigh; but each particular one has its fulcrum, or centre of motion, which is always on that side next to the first or general centre of motion of the whole: by which means the smaller moves upon the greater, as the toe upon the foot, the leg upon the thigh, and the thigh upon the body. The same also in the arms, the wings of birds, the tails of fishes, the oars of a boat, &c.

"These motions can be, and often are, inverted; as the thigh moving upon the leg, the body upon the thigh; or in birds, the body upon the wing, &c.: but then the smaller must be made the fixed point, which cannot happen without external resistance.

"It is the inverted motions, then, which produce the progressive; but it is necessary, for the production of a succession of them, to bring in also the motion of smaller parts upon greater; the two kinds of motion are therefore acting alternately whenever the progressive motion is carried beyond the first action.

"All animals which move upon the surface of the earth have that surface for their point of resistance: birds are supported and propelled in their flight by the air; and fishes, as also boats, by the resistance of the water." *John Hunter, MS. Croonian Lectures.*

1. *Progressive Motion in Water.*

a. *Fins of Fishes.*

279 A. The sterno-clavicular cartilage, scapulæ, and other cartilages of the pectoral fins of a Piked Dog-fish (Spinax Acanthias, *Cuv.*). On the right side are preserved some of the transparent horny filaments or bristle-like appendages that support the extreme edges of the membrane of the fin.

Donor, Mr. Clift.

279 B. The pelvic cartilages of the Piked Dog-fish. *Donor*, Mr. Clift.

279 C. The vertebræ and spinous processes which support the caudal fin of the Piked Dog-fish. *Donor*, Mr. Clift.

279 D. A similar preparation, showing in addition the transparent horny filaments which support the extreme edges of the membrane of the fin. The tail is the chief locomotive organ in fish, which impel themselves forwards by giving sudden and powerful lateral strokes to the water, bending the tail in two different directions: the other fins act chiefly as librators. *Donor*, Mr. Clift.

b. *Webbed Feet.*

280. The fore and hind foot of the American Bull-Frog (Rana pipiens, *Linn.*). Between the toes of the hind foot a membrane or web is extended to the last phalanx: this is employed in swimming, after the manner of an oar, striking the water by a broad extended surface.

281. The webbed feet of the Red-breasted Goosander (Mergus Serrator, *Linn.*). The hinder toe is provided, on the inner side, with a fin-like process of integument.

281 A. The fore-foot of the Ornithorhynchus paradoxus, in which the natatorial membrane is continued for some distance beyond the extremities of the toes, and is gathered into folds at each toe, which folds are concave towards the palm, and are supported behind by the strong elongated claws; a form of surface admirably adapted for striking the water with effect. *Prepared in* 1831.

2. *Progressive Motion in Air.*

282. A Flying-fish (Exocœtus volitans, *Linn.*). The pectoral fin on one side is partially expanded, showing its great extent of surface, which enables the animal to support itself in air for a short time after the body has received the impulse for motion at leaving the water.

282 A. A specimen of the Flying Lizard (Draco viridis, *Daudin*), in which a considerable fold of integument is produced laterally from the sides of the body, forming a parachute which supports the animal in the

air, and enables it to leap to a considerable distance from bough to bough. The membrane is supported by five elongated spurious ribs on each side; the first of which has a muscle extending and attached to its whole length, which draws it forward, when the rest follow, and the membrane is expanded. A bristle is placed beneath this muscle.

Prepared in 1831.

282 B. A specimen of the Horse-shoe Bat (Rhinolophus bihastatus, *Geoff.*), with the left wing expanded. This, as in the preceding specimen, is formed by a fold of the common integument, but is supported by the bones of the anterior extremity; the metacarpal bones and phalanges being remarkably elongated for that purpose. The pectoralis muscle and biceps flexor cubiti are dissected. A bristle is placed beneath the former.

Prepared in 1831.

282 C. A Humming-bird (Trochilus), with the wings extended, and the pectoralis muscle of one side exposed, which in this genus is remarkably powerful, and the keel of the sternum proportionately deep. As in all birds of great powers of flight, the first primary or digital quill-feather is the longest.

Prepared in 1831.

3. *Progressive Motion on Land.*

a. *Structures for Creeping.*

282 D. A portion of the vertebral column, with the ribs attached, of a large Serpent (Python Tigris, *Daud.*). The ribs are articulated to the transverse processes of the vertebræ by shallow ginglymoid joints, which admit of their being moved forwards and backwards on an axis passing perpendicularly through the joint. The ligaments, independent of the articular capsule, are so disposed as to limit the motions of the ribs to these directions: they are two in number,—one situated below the joint, which passes from the head of the rib to the transverse process, and thence is continued to the capsule of the intervertebral articulation; the other strengthens the upper part of the joint, and connects the neck of the rib to the transverse process.

The influence of the ribs in the progressive motion of serpents appears

first to have been observed by Sir Joseph Banks, who, in a large Coluber, saw them brought forward in succession, like the feet of a Centipede, as it moved along the floor of the room, and the motions could be distinctly felt in their extremities when the hand was laid flat under the belly of the animal.

The muscles which produce these motions in the ribs were in consequence examined in a Boa Constrictor, or Python, and are described by Sir Everard Home, and figured in the Philosophical Transactions, cii. 1812. p. 163. In the two following preparations they are shown in another genus of Serpent. *Prepared by Mr. Owen.*

282 E. A portion of the body of the Hooded Snake (Naja tripudians, *Merrem*), in which the muscles moving the vertebræ and ribs are dissected and exposed. The muscular columns on each side of the spine are analogous to those deeper seated muscles of the back, which appear after removing the Cucullaris and Latissimus dorsi in the higher animals that possess extremities for locomotion.

The mesial column (*Semispinalis et Spinalis dorsi*) arises by two series of origins; one series from the roots of the spinous processes, the other by short tendons from the transverse processes: the fibres pass forwards, coalesce after the manner of a penniform muscle, and terminate in long tendons which are attached to the summits of the spines. Two bristles are interposed between this muscle and the spines of the vertebra on the right side of the preparation. The column external to the preceding (*Longissimus dorsi*) arises by a series of fleshy origins from the transverse processes; the fibres pass forwards and outwards, are attached to the spinous processes by the medium of the fascia covering the preceding muscle, and ultimately are inserted into the occiput.

The third column originates from the fascia separating it from the preceding, and detaches, from its outer edge, long and delicate tendons which run forwards to be inserted into the ribs about half an inch from their vertebral extremities, presenting a striking analogy to the *Sacro-lumbalis*. This is shown more distinctly on the left side of the preparation, the fleshy column being raised by a bristle.

On removing the Semi-spinalis dorsi (which has been done on the left side of the spine), muscles are seen running obliquely between the transverse and spinous processes, and filling up the interspace between them, like the *Multifidus spinæ;* and beneath these, *Musculi Interspinales et Intertransversales* are situated.

External to the Multifidus spinæ is a series of short and strong oblique muscles, which, like the *Levatores costarum breviores,* arise from the transverse processes, and are respectively inserted into the rib attached to the succeeding vertebra. Where these are inserted, longer muscles (*Prætrahentes costarum*) arise, which run more obliquely backwards, each of which terminates in the eighth rib beyond that from which it arose; but is also inserted into all the intermediate ribs, and is closely connected to the intercostales. There is an appearance of a division of these long muscles into an upper and a lower portion by a middle transverse line, and these divisions are described as distinct muscles by Sir Everard Home in a large Coluber, but the two portions are strictly continuous in this species. The *intercostales,* which are hardly distinct from the preceding, have their direction downwards and backwards, and are continued to the extremities of the ribs.

In this preparation are also preserved portions of the two series of muscles which connect the integument to the ribs. Those of the upper series arise from the ribs, where the Levatores costarum are inserted, pass obliquely backwards, and are inserted at a little distance above the scuta: the lower muscles arise from the extremities of the ribs, and pass forwards to be inserted into the base of each scutum.

The actions of these several muscles are sufficiently obvious on inspecting the preparation. *Prepared by Mr. Owen.*

282 r. A portion of the body of the Hooded Snake, in which the internal muscles of the vertebræ and ribs are dissected and exposed. The muscles on the inferior surface of the spine are peculiarly developed; they arise from the transverse processes, and converge forwards to be inserted into the inferior spinous processes of the vertebræ. External to these are situated the *Retrahentes costarum,* which arise from the lower part of

the transverse processes, and after passing obliquely forward over three ribs, are respectively inserted into the fourth. Where these muscles are inserted, the *Transversalis abdominis* takes its serrated origin: its fibres descend obliquely forwards and terminate with those of the opposite side, in a common middle tendon, which closely adheres to the middle of the scuta.

On removing the Retrahentes costarum, there appears a stratum of short muscles which arise respectively from the head of one rib, and run obliquely backwards to be inserted into the next rib.

On removing the Transversalis abdominis, there appears a stratum of flat and broad muscles analogous to those which Winslow has termed *Sub-costales* in the human subject: they arise from the ribs where the Retrahentes costarum are inserted; pass obliquely downwards and forwards over one rib, to be respectively inserted in the next.

The cutaneous muscles seen in this preparation pass from the middle aponeurotic line to the scuta. *Prepared by Mr. Owen.*

4. *Structures for Burrowing.*

282 G. The anterior half of the body of a Mole (Talpa Europæa, *Linn.*), in which the diaphragm and principal muscles of the right extremity are dissected and exposed. *Prepared in* 1831.

282 H. The right tibia and fibula of the Koala (Phascolarctos fuscus, *Desm.*), with the interosseous muscle. *Donor*, Sir Everard Home.

" Among the extraordinary animals from New South Wales, the Wombat is met with, which is formed for burrowing; and another species of the same genus, the Koala, which exactly resembles it in its internal structure, is a climber, and lives on the tops of the highest trees; but in the night descends to the ground, and burrows in search of roots. These animals are the most perfectly adapted for burrowing of any we know; since their hind legs are formed in a different manner from those of any other species of quadruped, having a close resemblance to the human fore-arm, and this structure evidently for the purpose of burrow-

ing. As this is a new fact in comparative anatomy, I shall mention this structure more in detail.

" There is no patella, but the tendon of the extensor muscles of the leg, where that bone is usually situated, is much thickened. The fibula is proportionally larger than in most animals. At the upper extremity it is broad, and has two distinct articulating surfaces; the anterior of which is articulated to the tibia, and the posterior to a small bone of a pyramidal shape, which is connected to the tendon of the external head of the gastrocnemius muscle, like a sesamoid bone. The lower extremity of the fibula is large, and forms about half of the articulating surface for receiving the tarsus at the ankle. An inter-articular cartilage is here interposed between the tibia and the fibula, and another between the fibula and the tarsus.

" The fibula has a slight degree of motion on the tibia on its upper end, and a half rotatory motion on it at its lower end. Between the two bones is a strong muscle, which passes from the one to the other throughout their whole length; their fibres have their origin from the inner edge of the fibula, and pass obliquely inward and downward to be inserted into the opposite surface of the tibia. When this muscle contracts, it pulls the fibula forwards, and produces a degree of rotation on the tibia which turns the toes inwards. The anterior surface of the muscle is covered by a thin fascia or interosseous ligament; and there is another fascia less complete on its posterior surface. The muscle of the leg corresponding to the biceps flexor of the human body is inserted into the posterior part of the fibula, and is an antagonist to the muscle just described. Its action brings the toes back to a straight line, but does not turn them outwards.

" The use of this mechanism appears to be for throwing back the earth while the animal is burrowing. There is nothing at all similar to it in the hind legs of other burrowing animals, and it may therefore be adapted to particular soils." *Home, Lectures on Compar. Anat.* i. p. 133.

282 1. The left anterior extremity of the Echidna Hystrix, which exhibits in a marked degree all the peculiarities connected with fossorial habits; viz.

a broad extended palm, and strong trowel-like nails, powerfully developed muscles of the extremity, especially those of the hand, and a peculiar form of the humerus to afford them advantageous and extensive attachments; the condyles in this instance being so far produced in the lateral direction that the breadth of the bone at this part equals its length.

Prepared in 1831.

5. *Structures for Climbing.*

282 K. A Chameleon (Chamæleo planiceps, *Merrem*), exhibiting a form of the extremities adapted for grasping the twigs and smaller branches of trees, the three outer toes being directly opposed to the two inner; the tail has also the prehensile character. *Prepared in* 1831.

282 L. A Parrakeet (Psittacus Taïtianus, *Gmel.*), in which the foot has a similar disposition of the toes for grasping, and a form of beak well adapted for assisting in the climbing actions. *Prepared in* 1831.

282 M. The hinder extremities and tail of the two-toed Ant-eater (Myrmecophaga didactyla, *Linn.*). In the feet may be observed the peculiar inflected state of the toes, the heel serving as a fulcrum in the act of grasping. The tail is also prehensile, and devoid of hair and rugous along the lower part of the terminal half. *Prepared in* 1831.

6. *Structures for Leaping.*

283. The right hind-foot of a young Kangaroo (Macropus giganteus, *Shaw*), is an example of a part formed advantageously for springing. The second toe is broad, and produced far forwards, carrying the fulcrum of the lever to a considerable distance from the point of resistance, while the projection of the os calcis behind affords an advantageous attachment to the power. The two inner toes are very minute, and connate, except at the extreme point, where each of them has its own proper claw.

7. *Extremities formed with Parts for Progressive Motion only.*

284. A section of the hoof of a Horse, exhibiting externally the parts usually denominated the quarters and the coronet of the hoof; the bars of the

hoof and the frog on the lower part behind the sole; and the horny laminæ on the inner surface of the walls and bars.

285. The foot of an Ass, injected, from which the hoof has been removed to show the vascularity of the secreting organ of the hoof, and the laminæ on the exterior surface, called the sensible laminæ, to which the horny laminæ are adapted and firmly attached.

285 A. A section of the terminal phalanx, or coffin-bone of the Horse, with one of the lateral ligamentous cartilages attached.

Donor, Strickland Freeman, Esq.

285 B. A similar section of the coffin-bone of a Horse, with the lateral ligamentous cartilage, and part of the elastic ligamentous substance which is interposed between the flexor tendon and the horny frog, commonly called the soft or fatty frog. *Donor*, Strickland Freeman, Esq.

286. The bisulcate foot of a Calf, injected. The nail or hoof is removed from one of the toes, to show the vascular and sensible laminæ, similar to those in the horse, but much smaller.

8. *Extremities provided with Structures for seizing and tearing Objects of Prey.*

287. A toe from the right fore-foot of a Lion, with the last phalanx retracted on the ulnar (which from the prone state of the foot is the outer) side of the second phalanx. This state of retraction is constantly maintained, except when overcome by an extending force, by means of elastic ligaments, two of which have bristles placed beneath them in the preparation. The principal one arises from the outer side and distal extremity of the second phalanx, and is inserted into the superior angle of the last phalanx; a second arises from the outer side and proximal end of the second phalanx, and passes obliquely to be inserted at the inner side of the base of the last phalanx. A third, which arises from the inner side and proximal extremity of the second phalanx, is inserted at the same point as the preceding. The tendon of the flexor profundus perforans, which is the antagonist of the ligaments, has been divided.

287 A. A toe from the left fore-foot of a young Lioness, with the last phalanx drawn out, as in the action of the flexor profundus. The same ligaments are shown as in the preceding preparation, together with the insertion of the flexor and extensor tendons.

In order to produce the full effect of drawing out the claw, a corresponding action of the extensor muscle is necessary, to support and fix the second phalanx; by its ultimate insertion in the terminal phalanx, it serves also to restrain and regulate the actions of the flexor muscle. A bristle is placed beneath that part of the extensor tendon which passes under one of the elastic ligaments to be inserted into the base of the last phalanx immediately above the articulation.

In both preparations, lateral processes of tendon may be observed going to the under part of the base of the phalanx, which are partly inserted there, and partly lost in the integument: they are given off from the extensor tendon as it passes over the proximal phalanx, and are joined by ligamentous fibres from the sides of the same phalanx.

Prepared in 1831.

288. A toe from the right hind-foot of a Lion, with the last phalanx drawn out, and the elastic ligaments put on the stretch. As the phalanges of the hind-foot are retracted in a different direction to those of the fore foot, *i. e.* directly upon, and not by the side of the second phalanx, the elastic ligaments are differently disposed, as may be seen by comparing this with the preceding preparation. The outer ligament is of a flattened triangular form; it arises from the whole outer side of the middle phalanx, is strongest at the anterior margin, and is inserted at the superior angle of the last phalanx: the inner ligament is of a rounded form, arises from the inner side and distal end of the second phalanx, and is also inserted at the superior angle of the last phalanx, which is necessarily drawn back in the diagonal of the elastic forces.

288 A. The innermost toe, or pollex, of the right fore-foot of a young Lioness, exhibiting a disposition of the elastic ligaments, and mode of retraction, similar to the toes of the hind-foot; but here the inner ligament is of the flattened triangular form, and the outer one rounded. The latter

passes between a division in the extensor tendon, one part of which is inserted in the base of the last phalanx, just above the articulation; the other part into the outer side of the base of the phalanx, and into the integument.

It seems scarcely necessary to allude to the final intention of these beautiful structures, which are, with some slight modifications, common to the genus Felis. The claws being thus retracted within folds of the integument, are preserved constantly sharp, and ready for their destined functions, not being blunted and worn away in the ordinary progressive motions of the animal; while at the same time, as soft parts only are brought in contact with the ground, this circumstance contributes to the noiseless tread of the feline tribe. *Prepared in* 1831.

Subdivision II.

ORGANS OF DIGESTION.

Series I. Structure and Growth of Teeth.

On Teeth.

As the stomach is the digesting organ of the food of animals,—is in common a containing part in the form of a bag or bags,—and as it is generally placed on the inside of the animal, there must be an external communication to that cavity: and as the food is either passive, as vegetables, or active in contradiction to that process, as most animal food, there must be a mode of collecting, catching, adapting, and conveying that food to, and through that communication to the stomach.

Various are the means of doing all these operations; and this variety of modes arises from the nature of the food which the animal lives upon, different modes of digestion (as the difference between a ruminant and a horse), also a great variety of circumstances attending that food, the nature of which when caught may be often similar. The first of which (circumstances) I shall reckon fluidity, as honey, the juices of plants, such as what many insects live upon, &c. Secondly,

being alive, therefore a mode of catching and killing, which requires a greater extension of parts, and then to separate parts from the whole. Thirdly, collecting parts of growing vegetables; all of which have parts formed and adapted for such purposes. Most of these operations are performed by the mouth, or beginning of this communication in some animals; and in many others by the mouth with its other apparatus, as teeth; but it has often still more exterior assistance, as hands, claws, feet, &c.

These operations may be divided into three, although all the three are not necessary in every animal. The catching and collecting is the first: the fitting some food for digestion, and adapting most for deglutition, is the second: and the conveyance of that so collected and adapted into the stomach, is the third.

The mouth, which is the principal actor in these operations, is, in many, formed alone for these operations; and these formations are according to the nature of the food, and circumstances attending that food, viz. the natural situation of that food; as honey, which requires an apparatus to get to it, which is a mode of many of the winged insects; the lips, as in some fish, as the sturgeon; the tongue, as in the ant-bear, &c.

The parts of an animal immediately preparatory to deglutition and digestion are divided, in those that live on solids, into two kinds, viz. bills or beaks, and teeth: to which, probably, may be added a third, viz. those (parts) of insects which are exterior to the mouth. A mixed kind may, also, probably be added, viz. those that may be classed either with the teeth or with the bill, such as the dividers of some reptiles, as the snail, leech, &c. The bills are exterior, and are placed on, or surrounding, the mouth of the animal: they are of the same shape with the mouth, making a case for it; and as the mouth is made up of two parts opposing one another, commonly called upper and lower jaw, the bill is also composed of two parts, or a pair.

That class of parts of an animal preparatory to deglutition and digestion called teeth is so extensive, and of such various forms and uses, that it is uncertain in some cases what parts ought to be classed among the teeth and what not; and in those where they are evidently for this purpose, it becomes difficult to class them either according to their various uses or their forms*.

* Further on in the MS. Catalogue appears the following passage, through which the pen had afterwards been drawn. "Teeth are parts which cannot in any respect be classed according to the other

In some animals there are teeth for deglutition and others for digestion, as the nippers (*mandibulæ et maxillæ*) of a crab or lobster, while those for digestion are in the stomach: and where teeth were not necessary for digestion, they are wholly for deglutition, as the grinders in a lion, cat, &c.

The teeth are always placed between what may be called the brim or margin of the mouth, and the first intestine; viz. (in the) mouth, œsophagus, and stomach. Those subservient to deglutition are always placed in the mouth, viz. between the margin of the mouth and the œsophagus, having at the mouth a border of soft parts surrounding them, called lips, which is much more in some animals than in others, and which is the beginning of the mouth.

The mouth is the most frequent situation of the teeth, at least in those animals we are most acquainted with, viz. quadrupeds, amphibia, fish. In some reptiles they are placed in the œsophagus, as in the —— and ——*; and in some animals they are placed in the stomach, as in the water-insect or crab, &c.

Those in the mouth may be divided into two situations:—First, all those forming two rows in each jaw (i. e. one row in the right, and another in the left jaw), and opposed by similar rows in the opposite jaws; Secondly, where the teeth are placed on other parts, as the tongue. The first situation admits of divisions, as where those rows are single, as in the quadruped and amphibia: in others they are double, triple, &c. rows, as in many fish,

organs of the animal, but must be considered entirely with the food, as the only thing to which they belong: but as the food is always adapted to the organs of digestion, so far the teeth and those organs will always coincide.

"The teeth are adapted to the dividing, and masticating or grinding the food proper for the animal; but besides all this, are adapted to the catching of it, as in many fish and wild animals. Teeth also are in many a defence from enemies, and seem entirely given for this purpose, as in the tusk of the elephant. Teeth, besides these general uses, serve many secondary purposes in different animals.

They may be classed in this way:

Prensores simple.
——— with Laniarii.
——— ——— and Molares.

Incisores simple.
——— and Molares.
——— Laniarii.
——— Molares and Laniarii.
in the lower jaw only
formed like chisels."

* Quere, Myxine, Nereis? The term Reptiles is commonly applied by Mr. Hunter to the *Vermes* of Linnæus; whilst the *Reptilia* of the modern zoologists he usually denominates Amphibia or Tricoilia.

where the four rows mentioned are composed of a vast number of rows of teeth.

They may be classed according to their uses, which I shall at present reckon four, viz. holders or retainers, which may be called killers; dividers, crackers, and grinders, the two last of which may be thought the same.

The dividers are always more external than the grinders. Some dividers are always external, others are some way within, some more, as in the—(nereis?); some less, as in the snail. Some of the grinders are as far forwards as the dividers will allow them, as in those who have mouths filled with both kinds, as in most of the more perfect animals; but in many, those grinders are placed in the stomach, but then those have their dividers wholly external. Teeth are commonly fixed in or upon some bone, which (bones) are commonly the jaws of the animal; but this is not always the case, as in the lamprey, where there is no jaw-bone.

Some teeth grow to a given size, and then become stationary, as in most animals, viz. the human, &c.; some of which teeth last through life; others, of the same animal, are thrown off at given ages, called shedding of the teeth, and are again supplied by others, which last through life. In some other animals there is a regular succession of teeth, by the falling off or destruction of the teeth, and new ones continually growing and gradually coming into use; the new teeth being always a proportional size longer than the old: the jaws of which (animals) follow the same course, so that there is a regular succession of jaw and teeth growing. This is the case in many fish, as in all the ray-kind. In others there is a succession of young teeth growing at the basis of the old, or rather within the old, so that the old (tooth) drops out like a conical case, and the young one is uncovered. Probably the young tooth grows on the same pulp, so that these teeth never draw towards a point at the base, but always keep open or conical, yet do not always continue to grow, as the tusks.

Some teeth are wholly composed of bony substance, which is a mixture of two different substances, viz. a mixture of animal substance and calcareous earth: such are those of the ray-kind, alligator; as also some peculiar teeth of some animals whose teeth in general are not so simple, such as the elephant's tusk, boar's tusk, &c. The teeth of many animals are composed of the two abovementioned substances, but in one degree in a different manner, viz. one part being composed of bony substance, the other of calcareous earth alone.

Hunterian MS. Catalogue.